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ABSTRACT

A project explored less costly methods by which educational planning and control information could be collected, organized, and disseminated to appropriate planners and policymakers. An existing prototype computer simulation was refined and further developed by incorporating into it additional demographic, manpower, educational, and economic data by modifying it to accommodate additional variables and parameters, and by experimenting with various model computer simulation runs to provide a range of outputs and thus test the reasonableness and validity of the model for planning and policymaking purposes. The project result, Rhode Island Model II (RIM II) constitutes (1) a common demographic, manpower, and educational data base for dissemination and use by planners and policymakers and various levels in different State and local agencies; (2) a process and mechanism for improving communication and coordinating the efforts of State agencies involved in meeting occupation and training needs of the State's population, and (3) an analytic and planning tool to assist the Department of Education in analyzing the impact of different demographic and economic contingencies in the State's educational system and assess the consequences of alternative educational policies. RIM II is composed of five sectors dealing with the State population, labor market, student enrollments, educational costs, and educational benefits. These can be operated and analyzed separately or together. On the basis of data collected from a variety of sources, RIM II has been shown to successfully reconstruct the behavior of the system from 1960 to the present. It also extrapolates the behavior of the system into the future. It is recommended that RIM II be fully implemented within the State through model runs based on available data. (LAS)

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FINAL REPORT

Project No. 498 AH 50343

Grant No. OEG-007500326

An Information Network and Simulation Model for Vocational Education

Research Project in Vocational Education
Conducted Under
Part C of Public Law 90-576

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SUMMARY

This report presents the results of a research project conducted under a grant from the Office of Education, U.S. Department of Health, Education, and Welfare, during the period July 1975 through October 1976. The purpose of the project was threefold: (1) to establish within the State of Rhode Island a common demographic, manpower, and educational data base for dissemination and use by planners and policymakers at various levels in different State and local agencies, (2) to develop a process and mechanism for improving communication and coordinating the efforts of State agencies involved in meeting the occupational and training needs of the people of Rhode Island, and (3) to create an analytic and planning tool to assist the Department of Education in analyzing the impact of different demographic and economic contingencies on the State's educational system and to assess the consequences of alternative educational policies.

These goals were accomplished by organizing an educational information system task force and, most importantly, by further developing and refining an existing prototype computer simulation called the Rhode Island Model, which established the feasibility of using computer simulation models as educational planning and policymaking tools. The information system task force was composed of representatives of the State Departments of Education, Labor, Employment Security, Social and Rehabilitative Services, Statewide Planning, and Economic Development. It served to: identify missing or duplicated educational data elements and develop a means by which these data could be systematically collected and disseminated on a continuing basis; develop administrative procedures for establishing an information exchange network; and bring together collective judgements and experience to bear on the usefulness of the simulation model as an analytic and planning tool.

Further development and verification of the existing Rhode Island Model was done by incorporating into it additional demographic, manpower, educational, and economic data; by modifying it as required to accommodate the additional variables and parameters; and by experimenting with various model computer simulation runs to provide a range of outputs and thus test the reasonableness and validity of the model for planning and policymaking purposes. The ensuing improved simulation model, presented in detail herein, is called the Rhode Island Model II (RIM II) and offers an effective, versatile, easily implemented means of achieving the goals set forth in the first paragraph of this summary. RIM II is composed of five sectors dealing with the State population, labor market, student enrollments, educational costs, and educational benefits. These sectors can be operated and analyzed separately or together. On the basis of data collected from a variety of sources, RIM II has been shown to successfully reconstruct the behavior of the system from 1960 to the present. It also extrapolates the behavior of

the system into the future, and thereby allows simulation of economic-educational-manpower requirements on the basis of alternative forecasts of factors such as behavior of the economy, shifts in social priorities, and changes in the growth and composition of the population.

As a result of the success of RIM II in fulfilling its design purpose, it is recommended that it be fully implemented within the State through model runs based on available data. In addition, the model (1) should be used to investigate the effects of various educational policy alternatives that could conceivably be made by the State Board of Regents or Department of Education, (2) should be expanded by the addition of different sectors (e.g., a state tax sector to provide a better estimate of anticipated revenues, and a postsecondary school enrollment sector as related to population, the labor market, and economic conditions), and (3) should be geographically disaggregated into regional districts to permit its use as a local planning tool.

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Special acknowledgment is offered to the following persons for their participation on the project: Ms. Lucy Anderson for collecting and organizing large amounts of data from a variety of sources for incorporation into the model; Mr. Robert Sinche for developing the manpower forecasting equations; Ms. Barbara Entwistle for developing the Rhode Island labor force entry and separation rates by occupational cluster and skill level; Mr. Timothy Stryker for performing much of the initial computer programming; Mr. Robert Gurwitz for making extensive improvements to the SMT compiler, thus reducing computer operating costs and enabling the model to be run in an interactive mode; Mr. Walter Golembewski for technical editing of the final report; and Mrs. Henrietta Antonelli for her time and effort in preparing the final manuscript for publication.

CHAPTER I

INTRODUCTION

STATEMENT OF THE PROBLEM

The research project presented herein focuses on three related problem areas affecting the Rhode Island educational system: the need for providing current and anticipated demographic, manpower, and economic information for effective educational decision-making; the need for improving communications and coordination among the providers of vocational education and manpower training; and the need for developing a long-range analytic and planning tool that could be useful to planners and policymakers in various State and local agencies.

Information Needs

The collection and dissemination of demographic, manpower, educational, and economic information to appropriate users is an essential requirement for effective educational decision making. The procedure followed in many states has been to develop and implement, as resources become available, computer-based "management information systems" or "occupational and training information systems" -- often at considerable expense and not without problems in terms of complexity, unsuitability, and system maintenance. Similarly, the State of Rhode Island has developed and implemented a management information system for vocational education, which contains data on students, facilities, equipment, staff personnel, and programs in the public schools and at the State-run Rhode Island Junior College. This vocational education information system is designed as one module of a comprehensive educational information system, which has yet to be developed because of limited resources. Its usefulness for decision making is limited primarily because it lacks the above mentioned essential information that would provide an estimate of current and anticipated manpower needs within the State. In fact, a major recommendation of the Rhode Island Advisory Council for Vocational Education in its 1973 evaluation report was to "create an information system task force to integrate manpower, educational, and economic data into an effective statewide information system in order to maximize the attainment of vocational education goals."[1]

Interagency Coordination

Although Rhode Island's size limits the resources it can allocate to the development of management information systems, it does provide a unique opportunity for establishing planning relationships and information networks more readily among public and private agencies than is possible in larger states. It was recognized, particularly with respect to the Comprehensive Employment and Training Act (CETA), that Rhode Island needed to develop a

process and mechanism for improving communications and coordinating the efforts of State agencies in meeting the occupational and training needs of the people of the State. Too often, State institutions or agencies produce "comprehensive master plans" without considering the plans of other institutions or agencies. Usually, the planners involved have developed neither channels of interagency communication nor an awareness of the close interrelatedness of one another's problems. If there are any contacts at all, they are mostly on an ad hoc, informal, and personal basis. Both CETA legislation and the Federal Vocational Education Amendments established in 1976 offer recognition of and proposed solutions to these problems: the first, by setting aside five percent of Title I CETA funds for vocational education; and the second, by requiring that the five-year State plan (a requisite for Federal vocational education funds) be reviewed and approved by the State Manpower Services Council. These Federal mandates should contribute to the coordination of State and local planning for vocational education and manpower training.

Long-Range Planning and Analysis

As society becomes more complex and more technically oriented, the problems of creating and maintaining a competent work force become more severe. Technological changes create demands for new types of skills while diminishing or eliminating the demand for others. The less-educated and unskilled find themselves increasingly handicapped in the labor market as demand grows for higher levels of skill. The growing unpredictability and erratic behavior of the economy, variations in the rate of growth and composition of the population, shifts in the mobility and occupational composition of the labor force, and shifting social priorities and distributions of State expenditures, all contribute to making long-range educational planning and forecasting an extremely risky business. The extrapolation of major trends is becoming less reliable as a guide to the future. What is needed is a process and mechanism that can assist planners and policymakers in analyzing the effects of these external changes on today's educational plans and policies, in assessing the consequences of alternative educational policies, and in anticipating and responding to future educational requirements.

PREVIOUS STUDIES

In January 1974, the Rhode Island Department of Education, under the Department of Defense's Technology Transfer Program, contracted with the Naval Underwater Systems Center (NUSC) in Newport, Rhode Island, to investigate the feasibility of creating a prototype computer simulation model of the State's vocational education system. The purpose of any simulation model is to provide a framework for analyzing information or for explaining factors that cause or sustain a problematic state of affairs. Planning by computer simulation is also an attempt to reconstruct the structure and behavior of a complex system, such as an educational system, in order to understand its functioning, and con-

sequently, to anticipate potential alternative future developments of that system. A computer simulation differs only in complexity, precision, and explicitness from the informal subjective explanations or "mental models" that persons ordinarily construct to guide their actions toward a goal and to make decisions. (A more detailed discussion of computer simulation models is given in appendix A.)

The initial prototype model that resulted from working with NUSC was called the "Rhode Island Model" and is described in detail in NUSC Technical Document 4922.[2] It focused on vocational student enrollments at the secondary and postsecondary levels, the skilled and unskilled labor force, factors affecting students' decisions to enroll in vocational programs, and some measures of vocational education costs and benefits. Some components of the model lacked the data needed to test its validity or to make it useful to policymakers. However, the experience gained from developing the prototype indicated that the techniques used could be effectively applied in organizing and analyzing the large amounts of those types of data (demographic, manpower, economic, and educational) essential to educational policy decision-making.

It was also found that limiting the model to issues in vocational education presented certain disadvantages. First, there is a lack of generally accepted definitions as to what constitutes a "vocational" program. Business education and industrial arts at the secondary school level, and professional education at the postsecondary level are not considered vocational, but do prepare persons for entry into the labor market. Secondly, the costs of vocational education are not uniformly reported. In Rhode Island, for example, vocational education expenditures are reported separately only for what are designated "area" vocational-technical schools (of which there are nine), although some types of vocational programs are being offered in local school districts. Expenditures for these vocational programs conducted as part of local high school systems are not available. Thirdly, if one focuses on vocational education exclusively, there is no way of generating the comparative information needed to establish priorities for educational expenditures. The competition for scarce resources exists among elementary, secondary, and postsecondary levels; and (within each of these groups) between academic and vocational education at the secondary level, between undergraduate and graduate education at the postsecondary level, and so on. For these reasons, it was decided during the conceptualization phase of model development to include data elements beyond the usual scope of vocational education.

PROJECT GOALS AND OBJECTIVES

Since the State has limited resources for the development of management information systems, the major purpose of this project was to explore less costly methods by which educa-

tional planning and control information could be collected, organized, and disseminated to appropriate planners and policymakers. Based on the identified needs as listed in the preceding initial statement of the problem, three specific goals were set for this project: (1) to establish a common demographic, manpower, economic, and educational data base for dissemination and use by educational planners and policymakers at various levels in different State and local agencies, (2) to develop a process and mechanism for improving communications and coordinating the efforts of State agencies involved in meeting the occupational and training needs of the people of the State of Rhode Island, and (3) to create an analytic and planning tool to assist the Department of Education in analyzing the impact of different demographic and economic contingencies on the State's educational system and to assess the consequences of alternative educational policies.

PROCEDURES

Two basic procedures were used to attain the goals of this project. The first was the organization of an educational information system task force; the second, and most important, was the further refinement and development of the existing prototype computer simulation (i.e., of the Rhode Island Model).

Task Force Organization

The information system task force was composed of representatives of the Rhode Island Departments of Education, Labor, Employment Security, Social and Rehabilitative Services, Statewide Planning, and Economic Development. Specific objectives of the task force were to:

a. identify the source and availability of existing demographic, manpower, economic, and educational data in the State;

b. determine current flow and dissemination paths of information required by either Federal or State reporting procedures;

c. identify missing or duplicated data elements and develop a means by which these data could be systematically collected and disseminated on a continuing basis;

d. develop administrative procedures for establishing an information exchange network; and

e. bring the collective judgements of the members of the task force to bear on the usefulness of the computer simulation model as an analytic and planning tool.

The following agency representatives were assigned to the task force by their respective directors:

Reo A. Beaulieu (Task Force Chairman), Planner, Bureau of Research, Planning and Evaluation, Department of Education;

Lucy Hicks Anderson, Data Analyst, Bureau of Research, Planning and Evaluation, Department of Education;

Janet D. Dailey, Administrator, Statistics and Census, Department of Labor;

Frederick E. Hajjar, Administrator, Standards and Planning, Department of Social and Rehabilitative Services;

Raymond S. Mroz, Jr., Principal Management Analyst, Department of Employment Security;

Fred Santaniello, Monitory and Evaluation Specialist, Department of Economic Development, Division of Job Development and Training;

Chester F. Symanski, Principal Research Technician, Statewide Planning Program, Department of Administration; and

John J. Wilkinson, Consultant, Bureau of Vocational Education, Department of Education.

The task force met from September 1975 to February 1976 to identify the availability of data for the model and missing data elements. Subsequent to these meetings, Ms. Anderson, the data analyst hired for the project, contacted individual members of the task force to collect published or unpublished data available within their agencies.

Model Construction

Further development and refinement of the existing prototype Rhode Island Model was performed by Dr. Stanley Erickson, a systems analyst hired by the Department of Education. This was accomplished by first incorporating into the Rhode Island Model additional demographic, manpower, educational, and economic data; next, by modifying it as required to accommodate the additional variables and parameters; and finally, by conducting various model computer simulation runs to provide a range of outputs for testing the reasonableness and validity of the resulting model for planning and policymaking purposes. The description, application, and usefulness of the ensuing computer simulation model, which is called the Rhode Island Model II

(RIM II), make up the following three chapters in this report.

In the development of RIM II, arrangements were made with the Brown University Computer Center to use its computing facilities on a time-sharing basis. Brown University was selected because of its resident professional expertise in the areas of demography and labor economics, and because of its variable rate charges for computer time.

During the life of this project, additional personnel were hired to perform specific tasks such as computer programming, demographic computations, economic forecasts, and regressional analyses.

CHAPTER II

DESCRIPTION OF RHODE ISLAND MODEL II

RIM II is designed in five separate components or "sectors" which can be operated and analyzed independently or can be connected to show the interrelationships that exist between them. The five sectors of the model are (1) general population, (2) labor market, (3) student enrollments, (4) educational costs, and (5) educational benefits. The interrelationships of the sectors can best be described as a system of flows (people, information, goods, and services) which affect the levels (numbers of students, educational costs, employment, etc.) in each of the sectors.

The strength of the model lies in the fact that it incorporates relationships between the State's educational system, population, labor force, and economy within a single framework. It reconstructs the structure and behavior of the total system from the base year of 1960 to the present, either by half-year or whole-year increments, on the basis of data collected from a wide variety of sources; projections of future behavior are based on a number of assumptions that are made explicit in the model.

The modular design of the system allows flexibility in operating part or all of the model and permits it to be easily adapted to a large number of special purposes. Its structure can be modified by users having only a basic familiarity with computer simulation models to introduce new assumptions, to extend the subsectors to encompass the desired detail, or to add on special elements. The model allows the simulation of economic, manpower, and educational requirements on the basis of alternate forecasts of the behavior of the economy, shifting social priorities and distributions of State expenditures, shifts in the mobility and occupational composition of the labor force, changes in the educational and skill requirements of different jobs, and variations in the rate of growth and composition of the population.

Figure 1 presents an overview of RIM II, showing major information flows and relationships between its five sectors. In its broadest terms, the model states that the existing and anticipated demand for educational services is primarily a function of the size, age distribution, and characteristics of the population, the occupational structure of the labor force, and the perceived costs/benefits of various years of schooling as an investment in human resources. The sectors are designed to provide information on these anticipated demands in order that future educational resources might be allocated more effectively. A description of each sector, its output, and its relationship to other sectors follow.

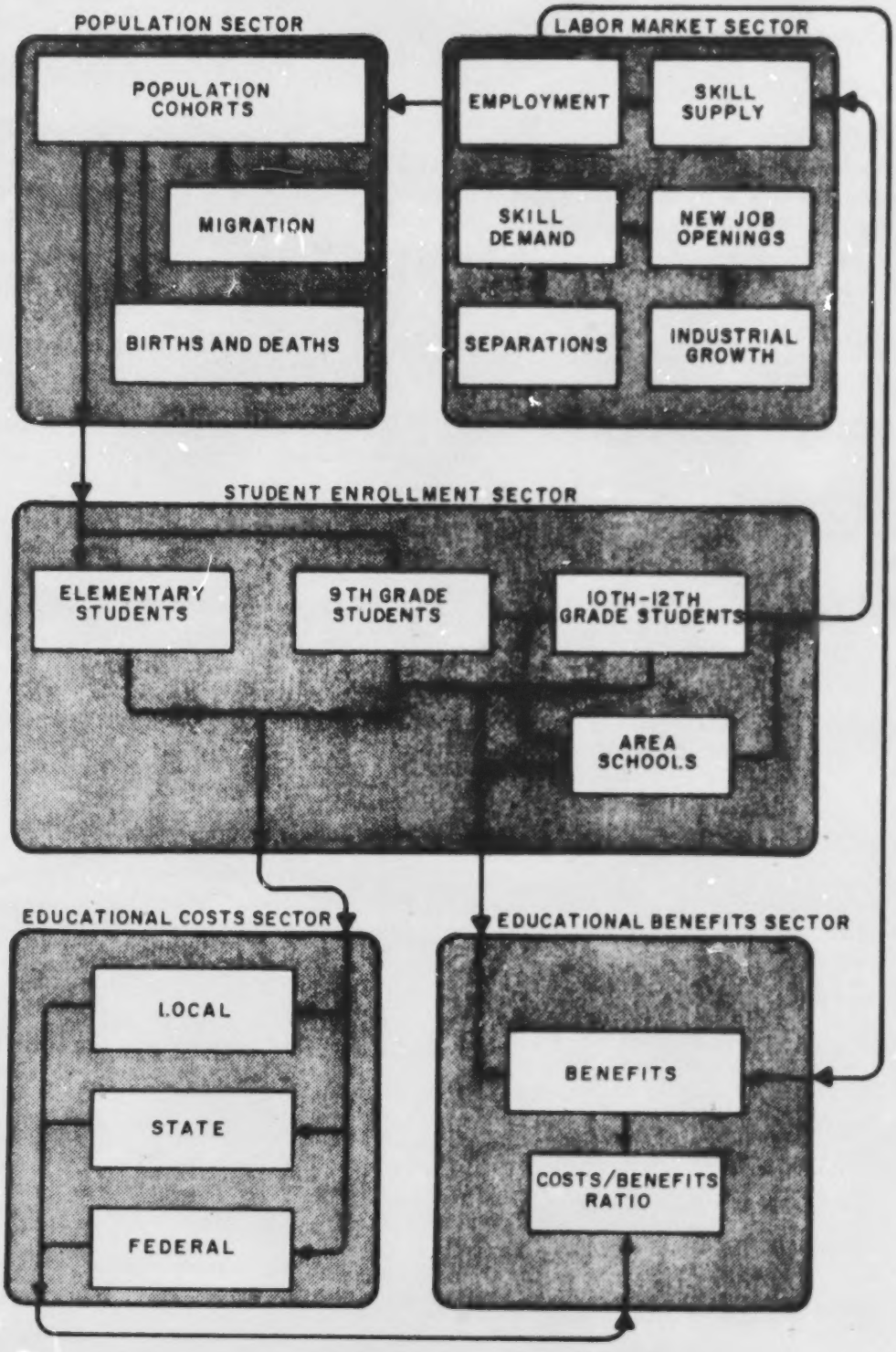

Figure 1. General Flow Diagram of RIM II

POPULATION SECTOR

At all levels of governmental planning, an estimate of population size and composition is of paramount importance in determining future demands for public services. The age distribution of the population will have an impact on the demand for educational and health services, on the available labor pool, and on the consequent ability of the State to pay for needed services.

The purpose of this sector is to provide an estimate of Rhode Island's current and anticipated population by specific age and sex cohorts. The sector is subdivided into twelve age cohorts by male and female population for each age cohort. The cohorts were selected on the basis of their relationship to the approximate ages at which students progress through different grade levels, and on the basis of their relationship to labor force composition, as shown in table 1.

Table 1. RIM II Population Sector Age and Status Divisions

Cohort Number	Age Division	Status Division
1	0-4	Pre-school
2	5-9	Grades K-4
3	10-13	Grades 5-8
4	14	Grade 9
5	15-17	High School or Area Voc. School
6	18-22	College or Junior College
7	23-27	Work, Childbearing Age
8	28-34	Work, Childbearing Age
9	35-44	Work, Childbearing Age
10	45-54	Work
11	55-64	Work
12	65 up	Retirement

The dynamics of Rhode Island's population have been estimated by a cohort-component method, which involves carrying forward the State's 1960 population by the selected age and sex cohorts to future dates by allowing separately for three factors: births, deaths, and migration. Data for calculating birth and death rates were obtained from the Rhode Island Department of Health, Division of Vital Statistics. Calculations of net migration flows for each age and sex cohort presented special problems, since no such comprehensive data are

maintained. Estimates of total migration by cohort were first derived as a residual from the difference of cohort population changes caused by births and deaths during the intercensal period (1960-1970) and the actual 1965* and 1970 census counts. The residual was then subdivided into five separate migration flows: military population-related, college student-related, housing-related, retirement-related, and job-related. The job-related migration is of the most interest for model purposes, since such migration is often considered an equalizing force between different regions of the country in times of recession, and between manpower supply and demand. A more explicit discussion of these components and the assumptions for making population projections follow.

Age-Specific Birth Rates

The Division of Vital Statistics maintains data on the number of births per year according to the age of the mother in five-year age groupings. The data represent births to Rhode Island residents, regardless of where the birth has occurred. From these statistics, an age-specific birth rate was calculated for the fifth through ninth female cohorts in the model, representing ages 15-44, for each year since 1960. An age-specific birth rate is defined as the number of births to women of a given age group per 1,000 women in that age group.

The trend in birth rates was linearly smoothed as a function of time in the model over the period of available data (1960-1974). This worked reasonably well except for a few cohorts in the early 1960s, when the birth rates were constant rather than declining. A 52/48 percent ratio of male over female births was maintained over this same period.

Age/Sex-Specific Death Rates

Data from the Division of Vital Statistics were used to calculate annual death rates by sex for each cohort from 1960-1974, in a manner similar to that used for the age-specific birth rates. Records are maintained by residence and not by place of occurrence. Age/sex-specific death rates were very nearly constant over the fourteen-year span of available data.

Migration

Migration is the third basic factor affecting change in the population and labor force of the State. A knowledge of the numbers and characteristics of persons entering and leaving the State is required to analyze the relationship of migration to the supply of skilled and unskilled labor, the growth of the

*A special census enumeration was conducted for Rhode Island in 1965.

economy, the demand for educational services, the State's unemployment rate, etc. As previously mentioned, net migration data are not readily available. Estimates of net migration by age determined from birth and death registrations over the intercensal period are theoretically exact.[3] However, this residual does not provide information on persons moving for job-related reasons, which is essential for the purposes of the model. In some sample surveys that have been conducted, attempts were made to distinguish between job-related and other (personal or social) reasons for moving, but these investigations were essentially in the exploratory stages of development.[4]

There are four types of non-job-related migrants that can be distinguished in Rhode Island and for which some data are available. These are students, military personnel and their dependents, retirees, and individuals moving for housing-related reasons. It is assumed for the purposes of this model that persons who move for other personal or social reasons into and out of Rhode Island are few in number, and that the net flow is negligible.

Student Migration. Since 1950, the U.S. Department of Commerce, Bureau of the Census has enumerated college students where they lived while attending college. In order to adjust total net migration estimates, the difference in numbers of Rhode Island students attending college out-of-state and of out-of-state students in Rhode Island had to be estimated. This estimate was made by first obtaining annual enrollments of out-of-state, undergraduate students at Brown University and at the University of Rhode Island from 1960 to 1972, which produced a trend curve for these students. Secondly, the number of out-of-state students attending all Rhode Island colleges was obtained from National surveys conducted in 1958[5] and 1968,[6] and from a regional study conducted in 1972.[7] By assuming that the number of all students, graduates and undergraduates, would follow the same trend curve for undergraduate students at Brown University and at the University of Rhode Island, the total number of out-of-state students by year for the period 1960-72 was derived.

The number of Rhode Island students attending colleges out-of-state in 1958 and 1968 was obtained from the same National surveys. Numbers for intervening years and for years after 1968 were interpolated and extrapolated linearly. It was also determined from census data that each graduate student had 0.80 dependents; each undergraduate, 0.18. The difference in numbers of college students attending college within or outside of the State represents the net migration flow of the student population and is subtracted from the total net migration estimates in the model.

Military Migration. The number of military personnel stationed in Rhode Island for each year since 1960 was obtained from the Department of Defense, as was the number of wives and dependents for the total Navy population. These figures included only shore-based personnel and not those assigned to ships based in the

Newport and Quonset areas. To obtain the total military migration in Rhode Island, a straight-line graph was plotted from a low of 24,800 in 1960 to a high of 30,000 in 1970. The rate of increase for the 1960-70 period was extrapolated to 1973, at which time the naval ships at Newport were reassigned to other home ports and the Quonset Air Rework Facility was disestablished. According to Department of Defense records, there were approximately 3,000 military personnel stationed in Rhode Island in 1975.

A more difficult task was the need to adjust the population cohorts of the model to coincide with the age structure of the military population and their dependents. This was done by creating migration flows. Navy personnel transferred into Rhode Island are typically of two types: senior enlisted personnel and officers who replace persons of similar rank and age for further Navy assignment; and new recruits, who normally replace first-term enlistees being discharged from the Navy. Between 1960 and 1970, there was a concentration of single, 19-year-old Navy personnel moving into the State and older personnel (21-22 years old) leaving the State. Military migration in the model was adjusted to conform to this dual flow of Navy personnel in different age groups. Also, it was assumed that the dependent ratio was larger for those personnel leaving the State than for those entering, due to births and marriages occurring while they were in the State. The estimates of military migration were used to adjust total net migration flows with the appropriate age profile.

Retirement Migration. It was found during the initial simulation runs that the model generated an oversupply of post-65-year-old persons in comparison with the 1965 and 1970 census data. This seeming oversupply may be due to the date on which the census is taken (April 1), when a number of retirees may be vacationing in the South. In any event, an out-migration flow of approximately 1100 retirees per year was established by the model.

Housing Migration. 1960 and 1970 census data provide information on the number of Rhode Island residents commuting out-of-state to work, and the number of out-of-staters (principally from Connecticut and Massachusetts) working in Rhode Island. Over the ten-year period, a net of 6,420 more persons of this category, plus dependents, resided in Rhode Island. It was assumed that these moves were related to the general suburban housing attractiveness of Rhode Island and lower property taxes relative to the contiguous states. The basic assumption in the model is that one-tenth of the total number moved annually during the intercensal period and that from 1970-1972 the general economic recession and slow housing activity reduced the annual flow to zero.

Job-Related Migration. The difference between the algebraic sum of the preceding migrations (student-, military-, retirement-, and housing-related) and total net migration, which was derived as a residual of birth and death registrations over the intercensal

period, is assumed to represent job-related migrants. A smooth flow of these migrants was established for the 1960-65 and 1965-70 periods in order to interpolate actual census data.

Rhode Island's unemployment rate exceeded the U.S. average by about one percent during the early 1960s, was approximately equal to it between 1965 and 1970, and has since far exceeded the U.S. average. Net job-related migration was relatively minor during the early 1960s and increased in the late 1960s. The basic assumption of the model is that job-related migrants are primarily motivated by the difference between the National and the Rhode Island unemployment rates. Lacking more reliable data than the 1960, 1965, and 1970 census enumerations, a linear fit of job-related migration versus differential (National-State) unemployment rates was constructed.

Final Population Adjustments

The number of Rhode Island residents by age cohort and sex as generated by the model was compared with 1965 and 1970 census data. The objective in construction of the model was to maintain less than a five percent deviation from the census data through all age cohorts and for both sexes. This objective was achieved by first adjusting the level of job-related migration to achieve agreement between the model and census data in terms of the total number of Rhode Island residents. The age profiles of military personnel, their wives, and their dependent children were then adjusted to make them agree with 1965 census data. (This single adjustment was possible because the net number of job-related migrants during the first half of the 1960s was quite small.) Third, with the military population defined, the age profile of job-related migrants was adjusted to achieve agreement of the model with the 1970 census. With these adjustments, population sector deviation from census data was less than six percent in all age and sex cohorts and less than two percent in a majority of cohorts. If we assume that the birth and death registrations are essentially accurate, and that available data, however incomplete, do indicate the levels of non-job-related migrants, the model can be used in predicting changes in population size and composition under various socio-economic assumptions.

Population Sector Flow Diagram

The following diagram, figure 2, illustrates the flows that have been accommodated in the model's population sector. Although not shown in the diagram for the sake of clarity, migration is also given according to cohorts for each of the subdivisions within the "Total Migration" block.

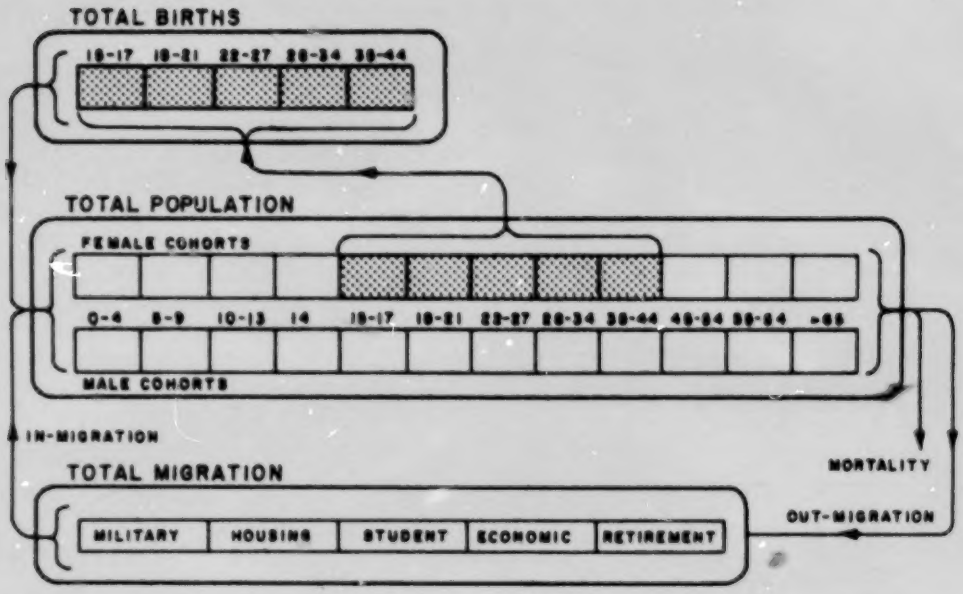

Figure 2. Population Sector of RIM II

LABOR MARKET SECTOR

Information on the structure of Rhode Island's labor market and anticipated employment opportunities is of critical importance to educational and vocational planning. Too often, workers are without jobs at the same time that jobs are unfilled because of a shortage of qualified workers. Recently, college graduates have encountered serious difficulties in finding employment related to their education. The lack of accurate, up-to-date occupational information and projections readily available to students contributes to the uncertainties of transitioning from school to work, and obscures the options that may have become open to future youth.

Structure of the Sector

The labor market sector of RIM II incorporates: data obtained from the Rhode Island Departments of Labor and Employment Security, 1960 and 1970 census data, and data from the U.S. Bureau of Labor Statistics industrial-occupational matrix. Labor force information has been converted or aggregated into the model by (1) converting the Standard Industrial Classification (SIC) occupational codes used by the U.S. Department of Labor into U.S. Office of Education (USOE) occupational clusters, (2) by establishing a skill level classification for various occupations, and (3) by estimating annual job openings due to labor force replacements. The labor market sector generates the Rhode Island employment from 1960 through 1985 by means of equations developed for each occupational cluster.

Conversion of SIC Groups into USOE Occupational Clusters

A major problem with published labor market data from an educational perspective is that the services-producing industries are collapsed into too few categories for planning and analysis. In Rhode Island, these industries employ over two-thirds of the State's labor force. Therefore, in the construction of the model's labor sector, the number of categories for services-producing industries was expanded through conversion of SIC occupational codes into USOE occupational clusters, which better accommodate these industries.

All but three of the USOE clusters can be related to the two-digit and three-digit SIC occupational codes. Persons receiving education and training in these three clusters (Consumer and Homemaking, Environment, Fine Arts and the Humanities) normally find employment in one or more of the SIC groups. Employment statistics by SIC industry codes were converted into the following specific USOE occupational clusters: Agri-Business and Natural Resources, Business and Office, Communications and Media, Construction, Health Services, Hospitality and Recreation, Marketing and Distribution, Personal Services, Public Services, Marine Occupations, Transportation, and Manufacturing. The manufacturing cluster was further subdivided into five major manufacturing groups to reflect the major industries in Rhode Island: Metals and Machinery, Jewelry and Silverware, Textiles, Non-Durable Goods, and Durable Goods. Table 2 presents the conversion of SIC codes to USOE clusters. SIC codes are defined in appendix B.

Table 2.
Conversion of USOE Occupational Clusters
To SIC Codes

USOE Occupational Cluster	SIC Codes
Agri-Business & Natural Resources	01, 02, 07, 08
Business and Office	06, 61, 62, 63, 64, 65, 66, 67, 73, 82 (Private), 86, 89, 81
Communications and Media	48
Construction	15, 16, 17
Health	80
Hospitality and Recreation	78, 79
Manufacturing:	
Metals and Machinery	34, 35, 36, 33
Jewelry and Silverware	391
Textiles	22, 23
Non-Durable Goods	20, 21, 26, 27, 28, 29, 30, 31
Durable Goods	24, 25, 32, 38, 39
Marine Occupations	091, 44, 373
Marketing and Distribution	50, 51, 52, 53, 54, 56, 57, 59
Personal Services	58, 70, 72, 76, 88
Public Services	49, 82(Public), 83, 84, 91, 92 93, 94, 95, 96, 97
Transportation	40, 41, 42, 45, 46, 47, 37, 55, 75

Skill Level Classification. James Scoville[8] has developed a manpower classification model that groups jobs in two ways: by job family (the types of jobs as defined by the functions about which the jobs are centered), and by the level of job content (the relative amount of skills and abilities which characterize the jobs). Job content levels were primarily determined by the levels of general educational development and by specific vocational development of various workers, based on the Estimates of Worker Trait Requirements for 4,000 Jobs.[9] Scoville shifted the basis of job classification from socio-economic status, used by the Bureaus of Census and Labor Statistics, to the more important bases of the technological focus and skill requirements of jobs. RIM II adapts Scoville's job content levels, such that what are referred to here as Level I occupations generally require four or more years of college; Level II, at least two years of college; Level III, high school graduation plus formal vocational training; Level IV, high school graduation and on-the-job training; and, Level V, general educational development.

The conversion of detailed 1970 census occupational titles into job skill levels involved a two-step process. The first aggregated the 407 census occupations into occupational families by cluster. As an example, the occupational families included in the Marine Occupations cluster are: Scientific, Engineering, Technical, Managerial, Clerical, Sales, Electrical, Fitters, Craftsmen, Mechanics, Seamen, Longshoremen, Fishermen, and Laborers. This approach approximates the Standard Occupational Classification (SOC) System, which is currently being developed at the National level and which may be ready for implementation during the 1980 census enumeration.* A full explanation of the methodology of conversion may be found in Volume 2 of this report, which also contains a summary of occupational projections for Rhode Island.[10]

*SOC is a grouping of occupations into homogeneous and related categories and sub-categories based on similarity of work performed. It would replace the current nine major occupational groups in the Dictionary of Occupational Titles (DOT) and the twelve major groups in the census. It is a four-level system, having divisions, major groups, minor groups, and unit groups. The twenty-one tentative Standard Occupational Classification divisions encompass: (1) executive, administrative, and managerial occupations; (2) engineers and architects; (3) natural scientists and mathematicians; (4) social scientists, social workers, clergy, and lawyers; (5) teachers, librarians, and counselors; (6) independent health practitioners; (7) writers, artists, athletes, and entertainers; (8) health technicians and technologists; (9) non-health technicians and technologists; (10) sales occupations; (11) clerical occupations; (12) service occupations; (13) agricultural and related occupations;

Each occupational family was then assigned to a skill level, based on the average general educational development and specific vocational training of workers in that family. The managerial and sales families presented special problems, since their classification by skill level varies with the industry or cluster in which they are engaged. For example, it would be unlikely that a manager of a personal services establishment would have attained the same educational level as a bank manager, or a manufacturer's sales representative the same level as a retail clerk. These particular occupational families were assigned to skill levels considered appropriate within a specific cluster.

An occupational cluster/skill level matrix was developed for Rhode Island's total employment in 1970, and also for Rhode Island male and female employment individually. These coefficients are presented in table 3. The coefficients are held constant in the current version of the model, although one would expect that with technological changes and educational upgrading of jobs they would change over time.

Table 3.
Employment Skill Level Coefficients

	Employment Skill Level Coefficients		
Skill Level	Total	Male	Female
I	.140	.160	.112
II	.101	.119	.075
III	.371	.357	.391
IV	.278	.236	.340
V	.110	.128	.082

Labor Force Replacements. The estimate of average annual job openings due to replacement includes workers who withdraw from the labor force because of deaths and retirements. Replacement estimates due to death are obtained from the age-specific death rate calculated in the population sector of the model. These are based on the assumption that the death rates for the total population and the working population are the same.

*(14) construction and extractive occupations; (15) transportation and material moving occupations; (16) mechanics and repairers; (17) precision working occupations; (18) production working occupations; (19) elemental occupations (laborers); (20) military occupations; (21) miscellaneous occupations.

RIM II replacement estimates due to retirement were prepared by first calculating the age and sex distribution for each skill level using Rhode Island 1960 and 1970 census data. Since the data are presented by five-year cohorts, Sprague* multipliers were used to find the fraction of working population at each skill level by any single age. Assuming that no male retirements occur before the age of 50, plotting the decline in male labor force participation after that age and for each skill level provides an estimated separation rate. This rate was then cross-multiplied with the age distribution by skill level for both the 1960 and 1970 census data. The result is an estimate of the number of male workers retiring per year since 1960 and projected to 1985.

Labor force separation rates for women are more difficult to estimate, since many leave the labor force during the childbearing years, reenter at age 35, then retire. The two periods of labor force separation for women were plotted and then averaged to estimate replacement needs by skill level, and the number of job openings for new entrants (and not re-entrants) by skill level. The result is an estimate of the number of female workers separating per year since 1960 and projected to 1985.

Jaffe and Carolton[11] have developed a more extensive method for estimating occupational mobility and labor force separations. This methodology was also applied to Rhode Island labor force data and the results of the two methods were comparable.

Manpower Forecasting Equations.**

The rationale for developing manpower forecasting equations, rather than carrying forward historical labor force trends in Rhode Island, was to provide a means by which the various sectors of the model could interact and by which users could select alternate assumptions or policies and determine their impact on manpower needs. Variables were selected on the basis of economic

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* The Sprague formula is designed to interpolate between a given series of points and to smooth the junction of the interpolations made for one range of data with the interpolations made for the next (adjacent) data; such as, interpolating by single years the age cohorts of 25-30 and 30-34. A further explanation of the Sprague multiplier may be found in appendix C, table C2 of reference 3.

** Mr. Robert Sinche, doctoral candidate in Labor Economics at Brown University and currently employed by the U.S. Department of Labor, N.Y. Regional Office, as a Special Assistant to the Director, organized much of the data for this section, did the regression analyses, and developed the forecasting equations.

theory and tests for statistical significance on yearly time series data from 1950 or 1958 through 1974, depending on availability. Appendix C provides a summary and cites the sources of the data series used for these analyses.

Manpower forecasting equations were developed for each occupational cluster of the labor market sector. Generally accepted levels of statistical significance have been observed in the identification of the independent variables in the equations. Table 4 is a summary of the independent variables that were found to be statistically significant in explaining employment in each occupational cluster. Regressions were made with a number of other variables, such as State expenditures for capital development, medical cost index, etc., but only the ones presented in table 4 were found to be significant. The R^2 values in the table indicate the degree (as a percentage) to which variation in employment is explained by the chosen independent variable.

Table 4.
Statistically Significant Independent Variables for the Manpower Forecasting Equations

Occupational Cluster	Independent Variables	R^2 Values
Agri-Business	Real per capita income	.95
Business and Office	Real GNP	.95
Communications and Media		.58
Construction	Real per capita income	
	Price index (construction)	.97
Health	R.I. total population	
	Population over 65	.98
Hospitality and Recreation	Real per capita income	.95
Manufacturing	R.I. State sales tax	
	R.I. corporate income tax relative to average of other states	
	Real per capita income	
	Productivity index (manufacturing)	
	Real GNP	.86
Metals and Machinery	Real GNP	
	Productivity index (durable goods)	.75
Jewelry and Silverware	Real GNP	
	Time	.53
Textiles	Relative textile wage (R.I./U.S.)	.95

Table 4 (cont'd.)
Statistically Significant Independent Variables for the Manpower Forecasting Equations

Occupational Cluster	Independent Variables	R^2 Values
Non-durable goods	Productivity index (textiles) Real per capita income Percentage increase in real GNP	.92
Durable Goods	Real GNP	.90
Marketing and Distribution	Real per capita income R.I. State sales tax Productivity index (trade)	.95
Transportation	Real per capita income Productivity index (transportation)	.85
Personal Services	Total R.I. population Percentage change in real per capita income Population over 65	.99
Public Services	Total R.I. Population Population over 65 Real per capita income	.99

Further investigation is required to identify other variables that may be significant for those clusters that have low R^2 values, such as jewelry and silverware, communications and media, and metals and machinery. It also should be noted that manufacturing employment is highly dependent on the state of the National economy, supporting the general belief that much of Rhode Island's industries are "export" industries. Employment in public and private educational services should also be disaggregated from public services and business and office, respectively, to determine more accurately the effect of declining birth rates on employment in these clusters.

STUDENT ENROLLMENTS SECTOR

The purpose of this sector is to provide an estimate of anticipated school enrollments by monitoring the flow of students into the public and non-public educational systems. Student data are based on statistical tables compiled by the State Department of Education[12] and on historical data contained in Rhode Island Undergraduate Enrollment Projections, 1977-1993, which was prepared by the Bureau of Research, Planning and Evaluation.[13]

Since the focus of this model is the elementary, secondary, and vocational education system in Rhode Island, student data include enrollments for the nine State "area" vocational-technical facilities, plus enrollments for vocational students at the junior college level. High school enrollments are subdivided into college preparatory, general curriculum, and local high school vocational education enrollments, which are expressed as fractions of total enrollment. These fractions however, are estimated, rather than based on reliable data.

Total Student Enrollments

The younger age cohorts of the general population sector of the model provide the universe from which total enrollments are drawn. These figures are adjusted by school participation rates by age groups, according to 1970 census data.

Public and Non-public Enrollments

The allocation of enrollments to public and non-public schools is based on available (1960-75) data. Although parochial schools experienced a sharp decline in the 1960s, in the standard run of the sector the enrollment ratio among these schools is assumed to remain constant from 1976 to 1985. This assumption is based on the fact that the Catholic Diocese of Providence has urged the formation of regional schools, which seems to have slowed or stopped additional parochial school closings.

Area Vocational-Technical School Enrollments

Enrollments in these schools are included in the model since the first such school opened in 1966. Projections are based on the design capacity of existing schools to 1985.

School Participation and Dropout Rates

Participation rates obtained from 1970 census data and checked with school census data are maintained until the ninth grade. Lacking more specific data, an 8 percent dropout rate is maintained for each grade between nine and twelve. It is recognized that these rates will vary with the student characteristics and the types of programs made available.

Labor Force Entries

The flow and allocations of students into the labor market are estimated on the basis of their level of educational attainment and on information concerning age/sex distribution of Rhode Island's labor force by skill levels. Thus, it is assumed that high school dropouts flow into Level V jobs; non-vocational high school graduates, into Level IV; and vocational high school graduates, into Level III. It is also assumed that most students leaving school who do not go on to further their education initially

seek entry into the labor force; their actual entry is adjusted by the average unemployment rates for younger workers provided by the State Department of Employment Security. It is assumed that a small fraction of the students leaving school do not seek work or continue their education.

Further Education Entries

The rate of high school graduates entering postsecondary institutions is maintained at a constant 0.56 percent, as assumed in Rhode Island Undergraduate Enrollment Projections.[13]

Relationship with Other Sectors

Anticipated enrollments in this scctor are used to calculate educational costs, entry rates into postsecondary institutions, and labor force entries by specific skill levels. The possible mismatch between educational programs and required occupational skills could be resolved by assuming a "manpower" approach to educational planning, as discussed in the educational benefits sector.

EDUCATIONAL COSTS SECTOR

The purpose of this sector is to provide an estimate of anticipated expenditures in the elementary and secondary schools of Rhode Island. Total educational expenditures from 1960 to 1975 were obtained from the State Department of Education Statistical Tables,[12] and adjusted to the Consumer Price Index base year of 1967. Since educational expenditures by elementary, secondary, and vocational programs are not uniformly reported among all school districts, the "weighted pupil" technique of the National Education Finance Project and the State's Full-State Funding Proposal was used. Under this technique elementary students were assigned a weighted score of 1.0; secondary students, 1.3; and vocational students, 1.8 (such that if $1,000 is assumed spent for each elementary school student, the expenditures for secondary and vocational students are $1,300 and $1,800, respectively).

The sector is divided into two subsectors: expenditures and resources. The expenditures subsector provides information on total costs and on costs by major categories: instruction, general control, operations, maintenance, fixed charges, and transportation. Instructional costs, which are used as a basis for determining the other costs, are a function of teacher wages, teacher/student ratios, and number of students.

Expenditures Subsector

State average minimum and maximum salary schedules since 1960 were obtained from the Rhode Island Educational Association. Separate teacher/student ratios were calculated for elementary and secondary students, based on the Statistical Tables.[12] The number of public school students is obtained from the enrollment sector of the model.

Fixed charges are largely fringe benefits added to instructional costs. Since the ratio of fringe benefits to instruction costs has been increasing almost linearly since 1960, a linear growth rate is assumed in the model from a low of 4.52 percent in 1960 to 20.5 percent in 1985. From 1960 to 1974, a nearly constant percentage has been maintained between instructional costs and the other budget categories of general control, maintenance, operations, and transportation. These ratios have been calculated at 10.5 percent for transportation, 3.6 percent for maintenance, 1.1 percent for operations, and 4.3 percent for general control.

Resources Subsector

The resources subsector identifies the sources and amounts of funding at Federal, State, and local levels. Information on Federal funds is provided in the Statistical Tables[12] by the laws which govern their distribution, such as Public Law 874 (Impact Aid), Vocational Education Amendments of 1968, and the Elementary and Secondary Education Act (ESEA) of 1965. These funds are grouped into non-ESEA and ESEA categories in the model and have been adjusted to the Consumer Price Index (1967=100).

The State Aid Formula determines the State share of educational costs. Since its adoption by the State General Assembly in 1960, it has had two major revisions, which have resulted in increasing the State's percentage. Between 1960 and 1964, the State avarage share was 28 percent; between 1965 and 1968, 31 percent; and since 1969, 36 percent. Although there have been minor fluctuations each year, these differences have usually been less than 1 percent. The balance of educational costs is a responsibility of the local community.

EDUCATIONAL BENEFITS SECTOR

The purpose of the educational benefits sector in the model is to provide a measure of the expected economic yield of an investment in education, as a guide to rational allocation of resources. The sector has been developed based on the findings of research studies, as reported by the National Education Finance Project[14] and others. Different approaches have been used in these studies to quantify the economic benefits of education and to conduct "cost/benefit" or "rate of return" analyses. There is no general agreement among educators and economists on the appropriate costs and benefits that should be included. It is also recognized that future benefits include non-economic benefits -- the social, political, and cultural consequences of education. Considering the present state of the art, these analyses are useful in providing additional indicators for making rational educational policy decisions.

There are two essentially different approaches that can be used in evaluating the relationships between education, manpower

and economic development. The first is the "human capital" approach, which attempts to measure the value of an increment of education embodied in a person either in terms of earnings differential (e.g., the difference in pay scales between college and high school graduates -- a private benefit), or in terms of his/her contribution to material production and economic growth (a social benefit). The second is the "manpower requirements" approach, which attempts to measure just what skills are needed for the efficient performance of jobs; acquired skills that are not used are considered economically wasteful from both an individual and societal perspective. As an extreme example, the first approach would lead one to the conclusion that the private and social benefits of a college education are positive, whether or not the person is employed, unemployed, or underemployed. The second approach would require the person to be employed in his field of training; otherwise, the benefits would be null. Many educational and manpower planning studies start with one or the other assumption, and later are qualified to arrive at some mid-position between the two extremes.

The rationale for developing the labor market sector of RIM II is based on the manpower requirements approach to educational planning. This educational benefits sector, however, was developed to provide some measure of the potential yield of educational investments, regardless of manpower needs. Three factors were included in developing this sector: earnings differential by educational level, the impact of certification or graduation on earnings, and the probable effects of a surplus of graduates (e.g., at the college level).

Earnings versus educational attainment curves by sex were developed using 1970 census data for Rhode Island. The average earnings for persons in the 25-30 year-old age bracket were selected, since persons in this group have had time to finish their education, but not to appreciably increase their earnings through on-the-job experience or longevity. The earnings of vocational education graduates have been plotted using the earnings of trades and industry workers for males, and the earnings of nurses and office workers for females. These curves are shown in figure 3.

The curves in figure 3 have two distinguishing features: gradual upslopes and abrupt rises. It is assumed that these features correspond to the two ways in which education advances wages: through certification or graduation, or through information acquired by each additional year of schooling (formal education). It is generally recognized that a diploma may not only be an entry requirement for various jobs, but may also be used to establish a specific salary schedule by the employer.

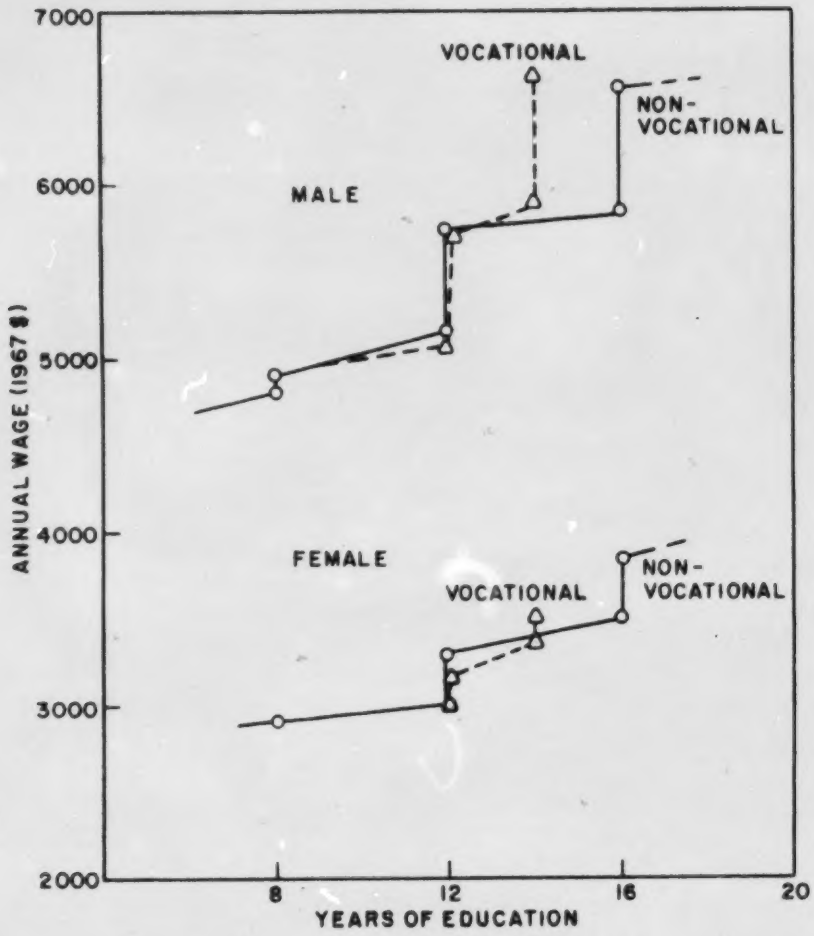

Figure 3. Earnings vs Educational Attainment by Sex

Since skills learned through formal education can also be learned through on-the-job training, salary differences between formally educated and non-formally educated workers will gradually decline. Therefore, a rough measure of the time needed to equalize this differential, traditionally called the "time horizon," is incorporated into the model. Since it is more difficult to overcome the handicap of not having a diploma than it is to overcome the lack of formally acquired job skills, a longer time horizon is used to equalize the effects of certification than is used to equalize the effects of formally acquired skills. In the model, 20 years is used as the time horizon for on-the-job training or further education to equalize the value of the diploma, while 10 years is the time horizon used for individuals with formally acquired skills but without certification.

Wage ratios between educational levels have been quite stable in the past, although very substantial changes have occurred in the proportions of persons at each level of educational attainment. Some economists are anticipating that the rates of return for college education will decline as more graduates flood the labor market and educational costs increase. To test this assumption, an equation has been included in the model so that as more and more persons attain a specific level of education, wages will decline proportionally for that particular group. The proportion has been arbitrarily set at 50 percent, such that if a college degree is worth $1,000 per year when virtually no one has it, it is worth only $775 when half the population has one, and $500 when it is universally achieved.

CHAPTER III

MODEL VALIDATION

A major step in the development of a simulation model is a check of its validity and sensitivity to changes in system variables, assumptions, and relationships. If the model is to be considered a valid simulation of a real system, it must reasonably duplicate past system behavior when historical input data are used. In addition, extrapolated projected values for different model variables must be reasonable. The purpose of this chapter is to compare historical data with the values generated by RIM II, and to show results of the standard run of the model used to project future behavior of the system.

POPULATION SECTOR

The model carries forward Rhode Island's 1960 population by selected age and sex cohorts to future dates by allowing separately for births, deaths, and migration. As described in the previous chapter, no comprehensive data are maintained for in- and out-of-state migrations. After calculating military, student, retirement, and commuter migrations, for which some data are available, the model assumes that economic-related migrations are caused by the difference in the National and State unemployment rates. Actual migrations are delayed by one year in the model to accommodate the average time that unemployed workers are eligible for unemployment benefits. Also, a decision variable has been introduced, which reduces the out-migration flow when the difference between the National and State unemployment rates exceeds 1.7 percent. The assumption is that above a 1.7 percent differential, the more mobile sector of the population has already migrated and those remaining have a considerable investment in the State (homes, family ties, etc.) which precludes their leaving. While making final modifications to the model, it was found that a number of adjustments had to be made in the estimates of the ages of the mother and dependent children in migrant families, which affect the model's values for total number of births and school enrollments. Additional data on age cohorts of the migrating population could possibly have reduced the number of adjustments to be made, but such data are not available.

The following assumptions have been made for the standard run of the population sector, which runs from 1960 to 1985:

a. birth rate declines at its actual rate until 1976, at which time the rate of decline becomes zero;

b. death rate remains constant until 1985;

c. student, military, commuter, and retirement migrations remain constant until 1985;

d. National and State unemployment rates are equal until 1985.

Total Population. Figure 4 compares Rhode Island's total population as generated by the model with census data, and shows 1985 population as projected by the standard run of the model. The Bureau of Census has recently estimated Rhode Island 1975 population at 926,000; the model generates a total population of 910,120 for 1975. The difference may be attributable to the economic migration assumptions that have been included in the model.

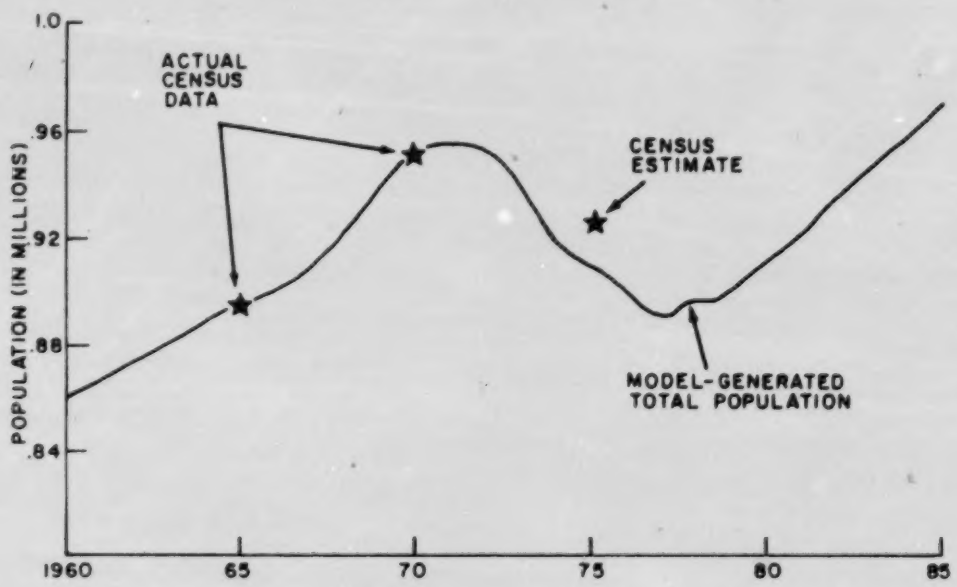

Figure 4. Actual vs Model-Generated Total Population

Population by Age and Sex Cohorts. Table 5 compares model-generated population by age and sex cohorts with census data in 1960, 1965, and 1970, and shows the model-projected population to 1985. Again, the standard run of the model was used to generate the data. Out-of-state college students in Rhode Island are not included in the model outputs. Two trends are notable: the declining school-age population and the increasing percentage of elderly in the State.

Table 5. Comparison of Actual and Model-Predicted Population by Age/Sex Cohorts

MALE Population* AGE Cohort	1960 CENSUS	1960 MODEL	1965 CENSUS	1965 MODEL	1970 CENSUS	1970 MODEL	1975 MODEL	1980 MODEL	1985 MODEL
0-4	46.0	46.0	43.8	42.4	39.3	39.6	33.2	30.6	32.8
5-9	40.3	40.3	44.5	44.4	43.9	44.5	37.9	34.2	34.1
10-13	31.9	31.9	33.5	33.6	36.0	33.7	30.9	28.8	27.8
14	5.9	5.9	7.9	7.9	8.9	8.4	7.8	7.5	7.3
15-17	19.2	19.2	22.5	22.4	25.1	25.6	24.5	23.3	22.6
18-21	28.4	28.4	28.6	30.1	41.9	35.7	27.0	26.8	27.7
22-27	30.2	30.2	27.6	32.4	45.7	42.9	36.4	37.0	43.5
28-34	36.9	36.9	36.3	32.8	34.2	37.3	39.1	40.8	47.7
35-44	58.6	58.6	56.3	54.2	50.6	52.1	50.8	52.4	57.1
45-54	48.9	48.9	51.9	51.5	54.9	52.4	49.5	49.1	51.1
55-64	38.2	38.2	38.7	39.0	43.8	41.2	40.4	40.0	41.4
65+	37.2	37.2	40.5	39.5	41.0	41.8	44.0	45.1	46.4

FEMALE Population* AGE Cohort	1960 CENSUS	1960 MODEL	1965 CENSUS	1965 MODEL	1970 CENSUS	1970 MODEL	1975 MODEL	1980 MODEL	1985 MODEL
0-4	43.7	43.7	43.4	40.5	37.5	38.0	31.7	29.4	31.6
5-9	39.7	39.7	43.5	43.0	42.0	43.1	36.5	32.8	32.9
10-13	30.1	30.1	32.8	32.9	34.8	33.5	30.7	27.9	26.8
14	5.8	5.8	7.8	7.5	8.6	8.1	7.7	7.3	7.0
15-17	18.5	18.5	23.6	21.7	24.7	24.9	24.0	22.9	22.1
18-21	20.1	20.1	26.5	26.8	33.4	32.3	31.6	30.7	29.9
22-27	26.8	26.8	32.9	29.3	40.8	40.0	42.6	46.8	52.5
28-34	39.2	39.2	33.7	33.1	34.3	36.5	40.5	47.0	56.7
35-44	62.2	62.2	60.6	57.6	53.1	54.7	53.7	56.8	64.6
45-54	53.9	53.9	57.1	56.4	60.2	57.1	54.6	54.3	57.2
55-64	44.8	44.8	47.0	46.8	50.7	49.6	49.6	50.0	52.0
65+	50.3	50.3	56.7	55.8	62.5	61.9	68.2	73.9	80.4

*POPULATION GIVEN IN THOUSANDS (LESS OUT-OF-STATE STUDENTS).

LABOR SECTOR

The model generates Rhode Island employment since 1960 using the equations developed for each occupational cluster and values derived from the cluster regressions. Deviations between the actual and model employment values are the result of the amount of variation not accounted for by the independent variables selected for the equations.

The standard forecast run of the labor sector uses the assumptions made by the Bureau of Labor Statistics in reference 15. These assumptions are:

a. a 2.5 percent annual increase in real per capita income to 1980, and a 2.0 percent annual increase from 1980-1985;

b. a 4.6 percent annual increase in real gross national product to 1980, and a 3.2 percent annual increase from 1980 to 1985;

c. a 5.6 percent annual increase in the productivity index for the communication cluster to 1980, and 4.9 percent annual increase from 1980 to 1985;

d. a 4.1 percent annual increase in the productivity index for the transportation cluster to 1980, and a 3.1 percent annual increase from 1980 to 1985.

e. a 3.1 percent annual increase in the productivity index for the durable goods cluster to 1980, and a 2.4 percent annual increase from 1980 to 1985;

f. a 2.0 percent annual increase in the productivity index for the textiles manufacturing cluster to 1980, and a 1.8 percent annual increase from 1980 to 1985;

g. a 3.1 percent annual increase in the productivity index for the marketing and distribution cluster to 1980, and a 2.5 percent annual increase from 1980 to 1985;

h. a 5 percent annual increase in the price index for the contract construction cluster to 1980, and a 4 percent annual increase from 1980 to 1985;

i. the Rhode Island sales tax will remain at 6 percent;

j. the relative corporate income tax will decline from 1.37 percent in 1974 at a rate of 0.02 percent per year.

The following graphs (figures 5-19) compare employment by occupational clusters generated by the model equations with employment data provided by the Rhode Island Department of Labor from 1960 to 1974. Employment in the marine occupational cluster is not included, since recent major changes in this cluster make the use of a forecasting equation unreliable. The graphs include the model's projections of employment to 1980 based on the Bureau of Labor Statistics assumptions.

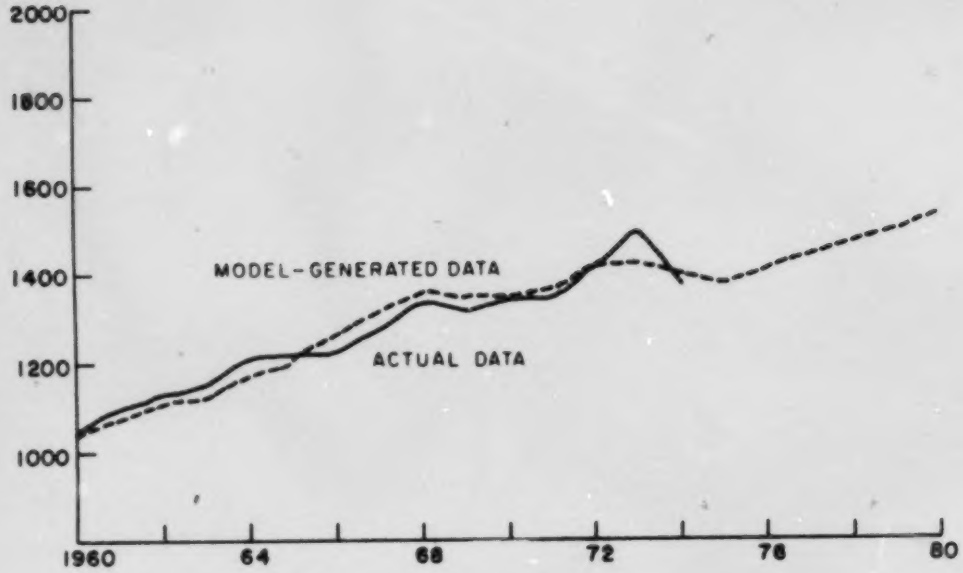

Figure 5. Actual vs Model-Generated Employment; Agricultural (covered)

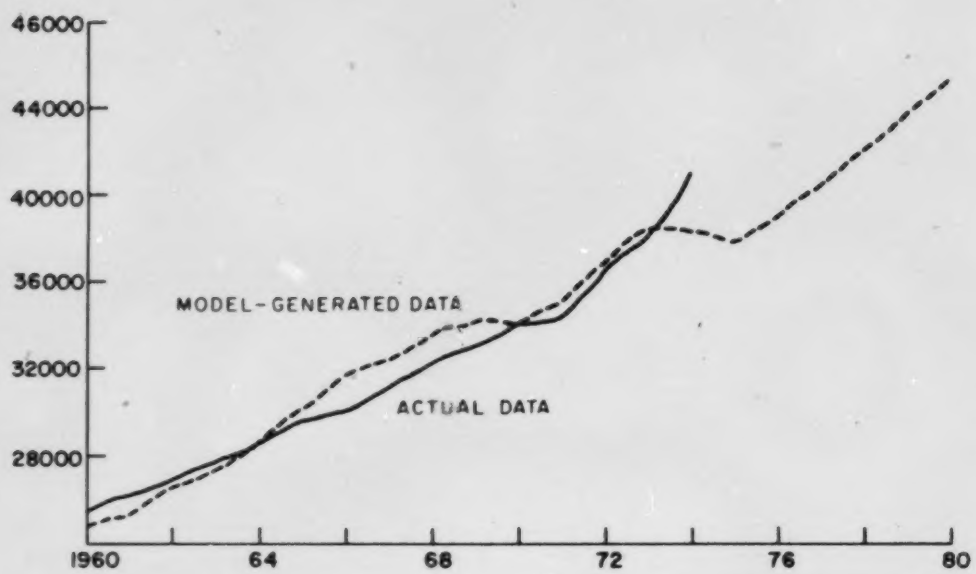

Figure 6. Actual vs Model-Generated Employment; Business and Office

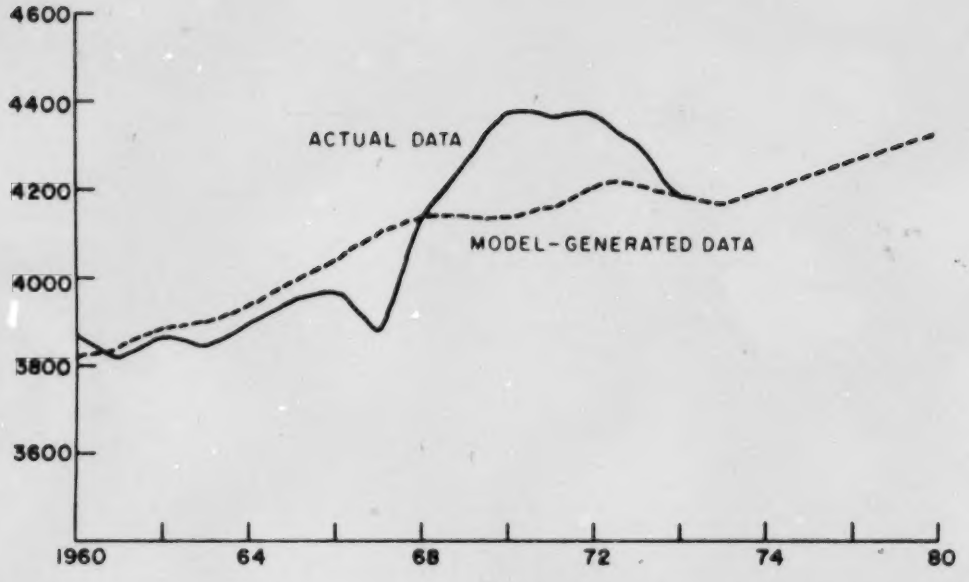

Figure 7. Actual vs Model-Generated Employment; Communications and Media

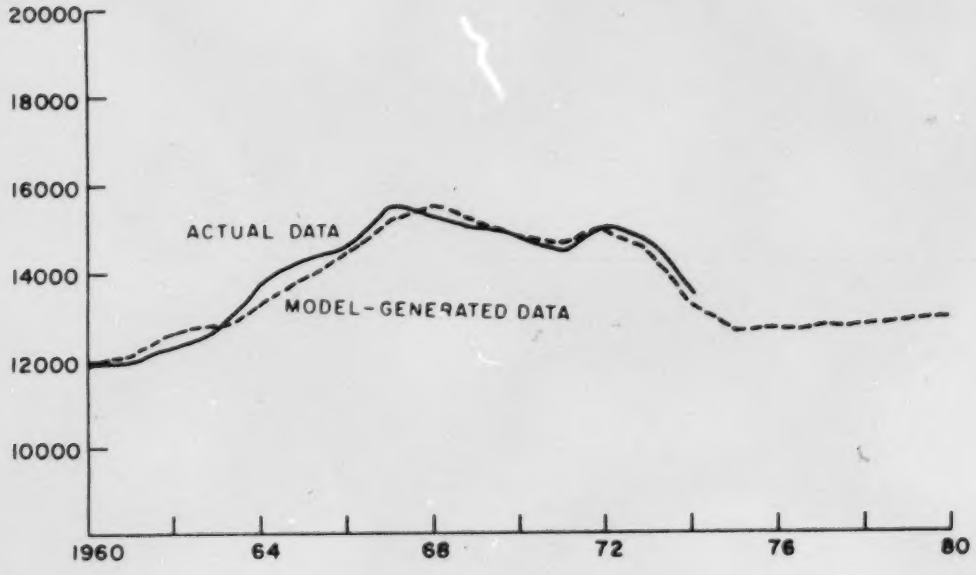

Figure 8. Actual vs Model-Generated Employment; Construction

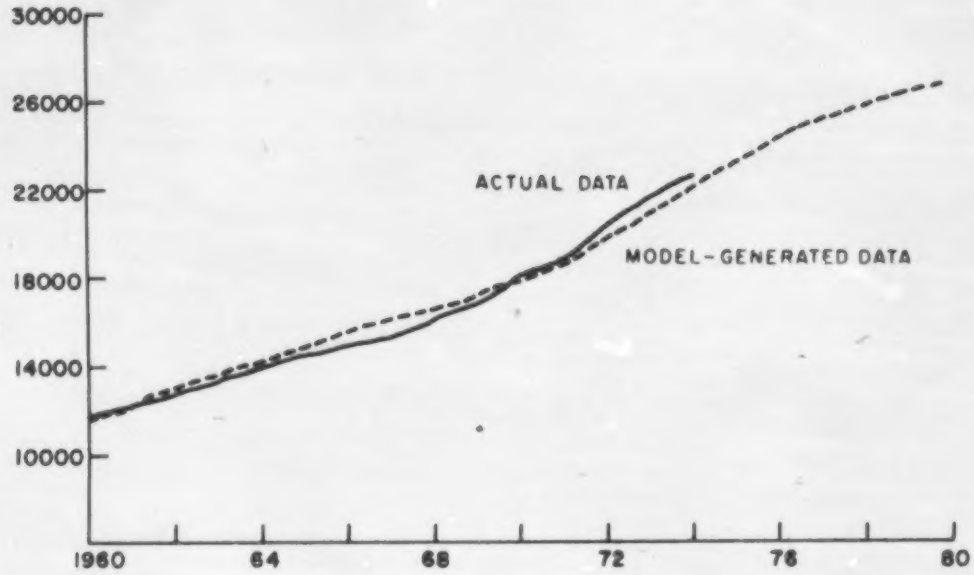

Figure 9. Actual vs Model-Generated Employment; Health Services

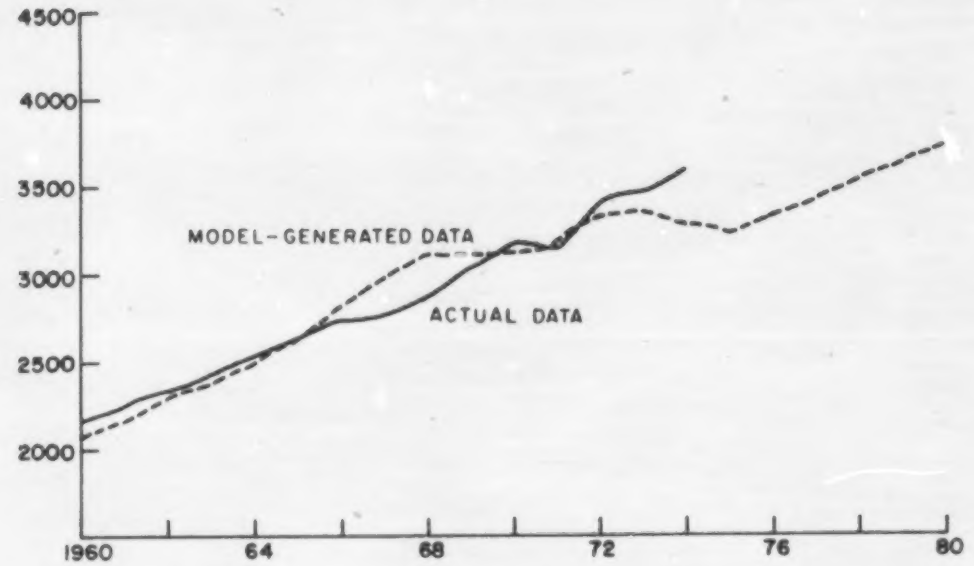

Figure 10. Actual vs Model-Generated Employment; Hospitality and Recreation

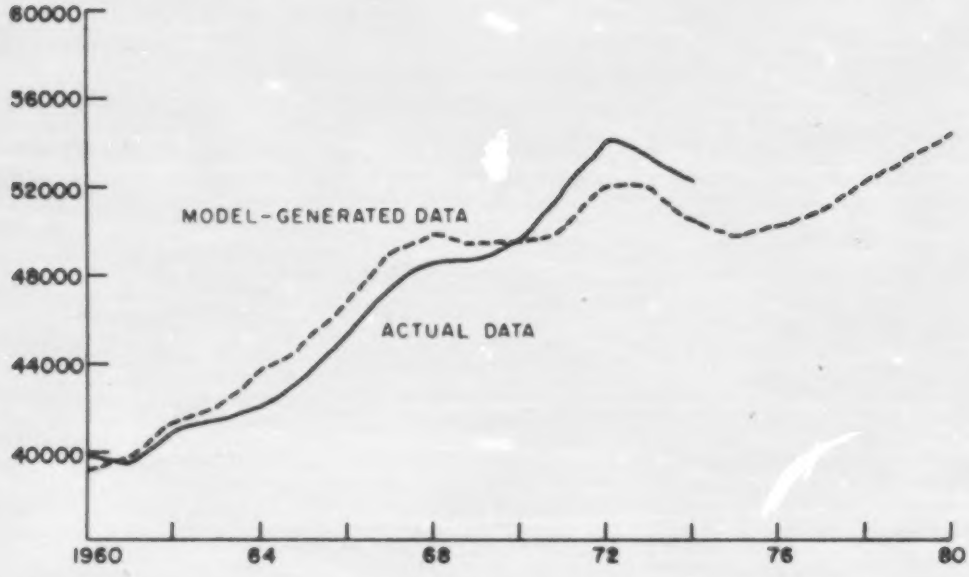

Figure 11. Actual vs Model-Generated Employment; Marketing and Distribution

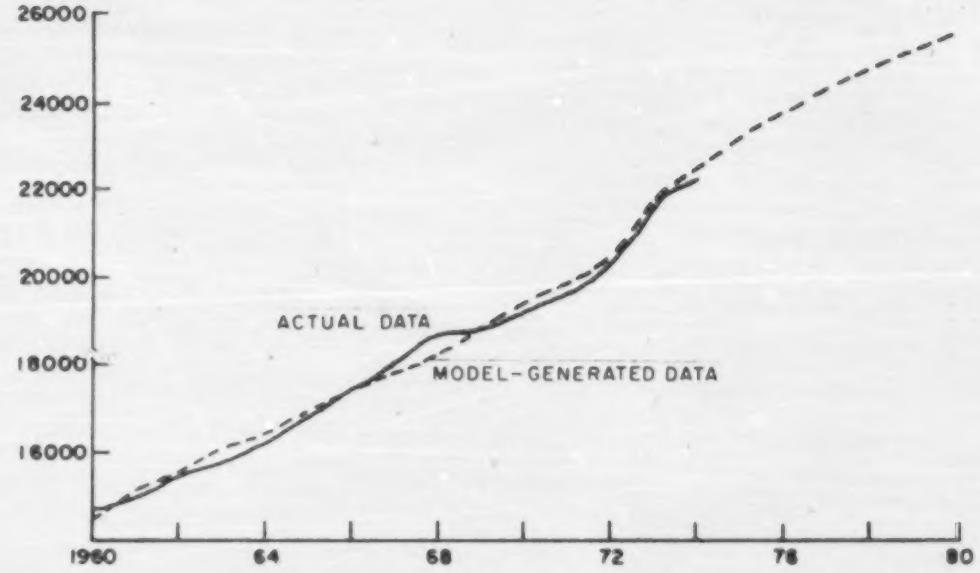

Figure 12. Actual vs Model-Generated Employment; Personal Services

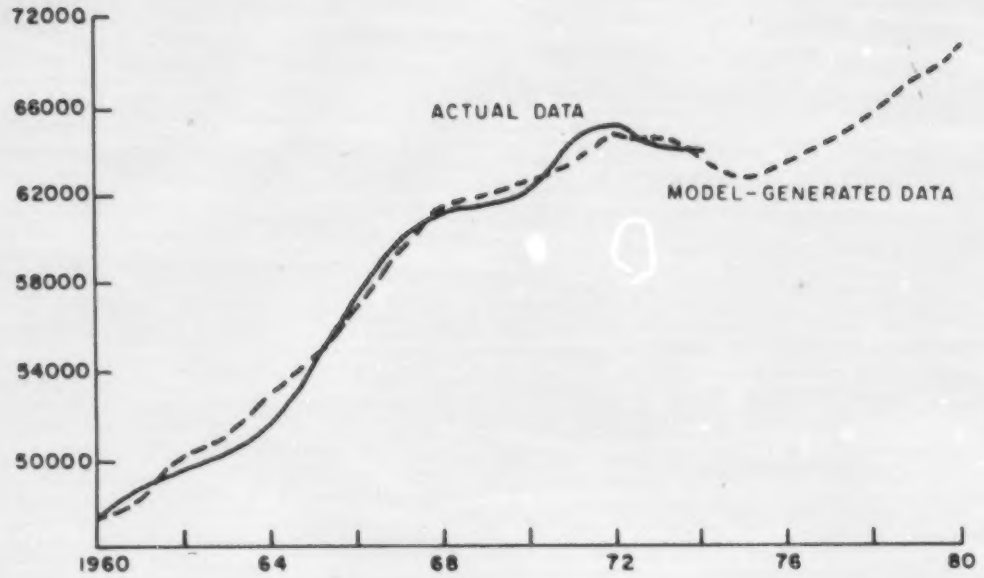

Figure 13. Actual vs Model-Generated Employment; Public Services

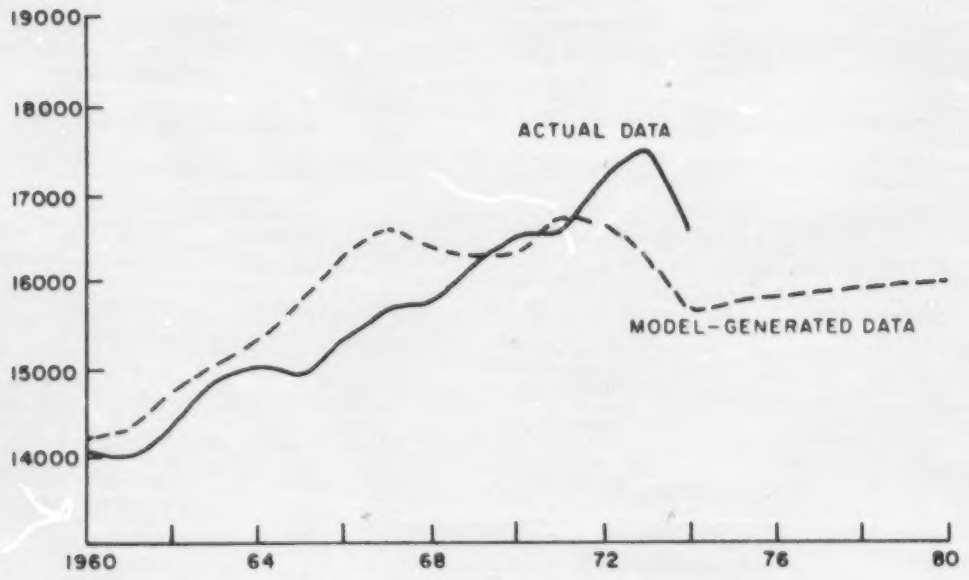

Figure 14. Actual vs Model-Generated Employment; Transportation

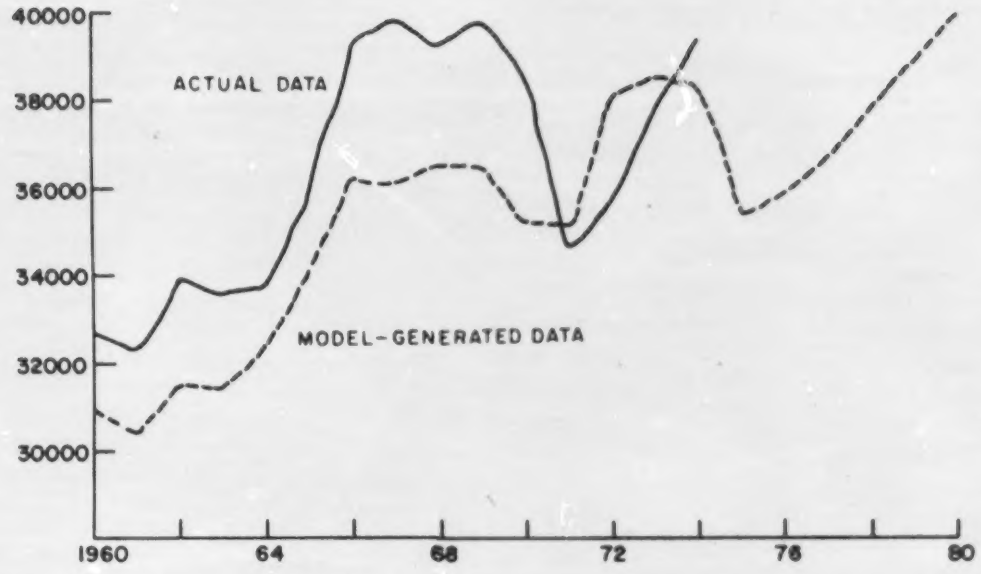

Figure 15. Actual vs Model-Generated Employment; Metals and Machinery

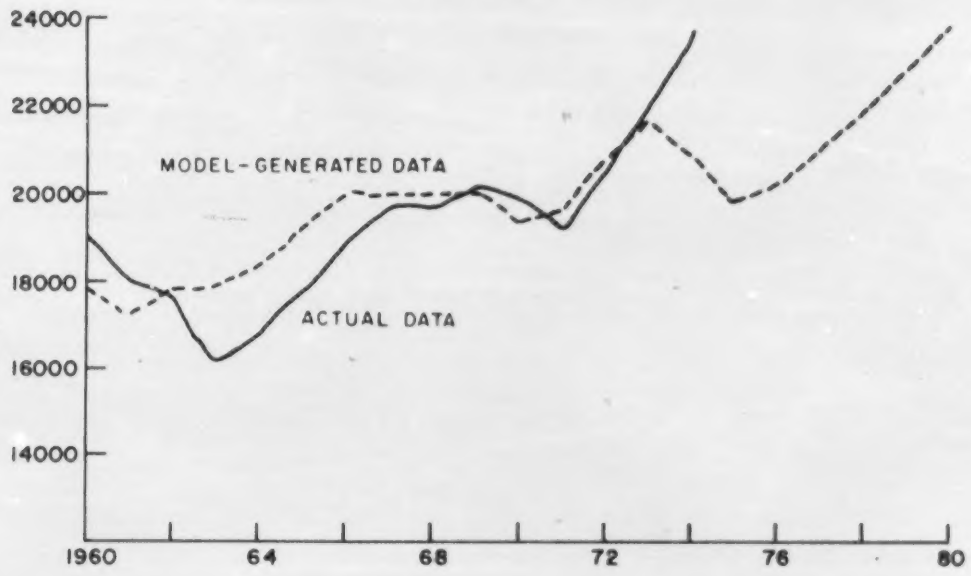

Figure 16. Actual vs Model-Generated Employment; Jewelry and Silverware

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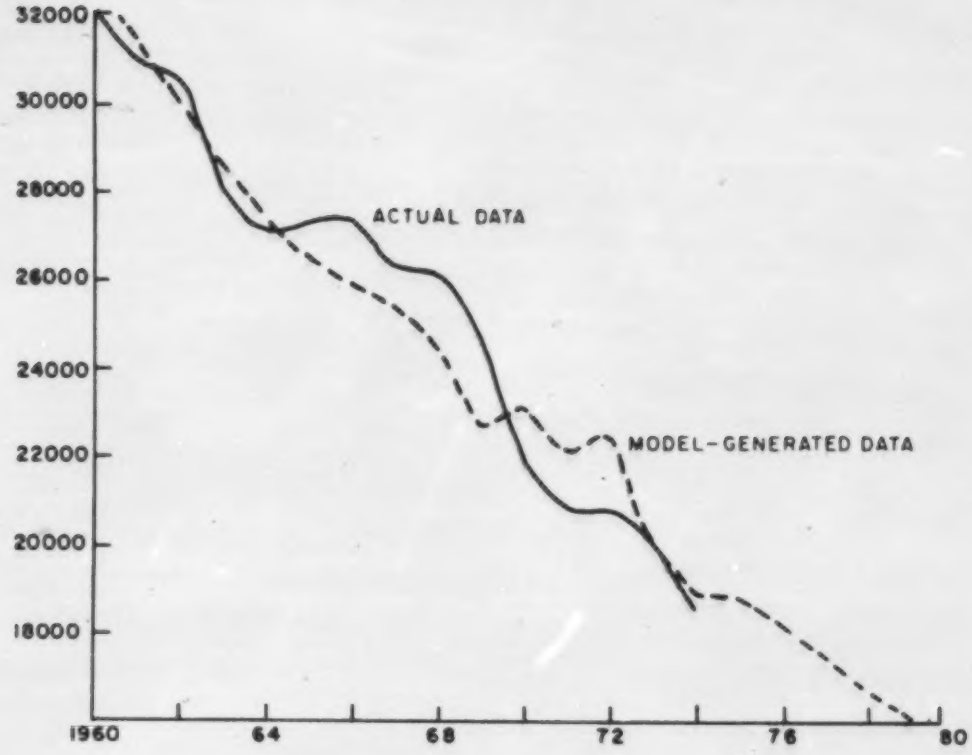

Figure 17. Actual vs Model-Generated Employment; Textiles

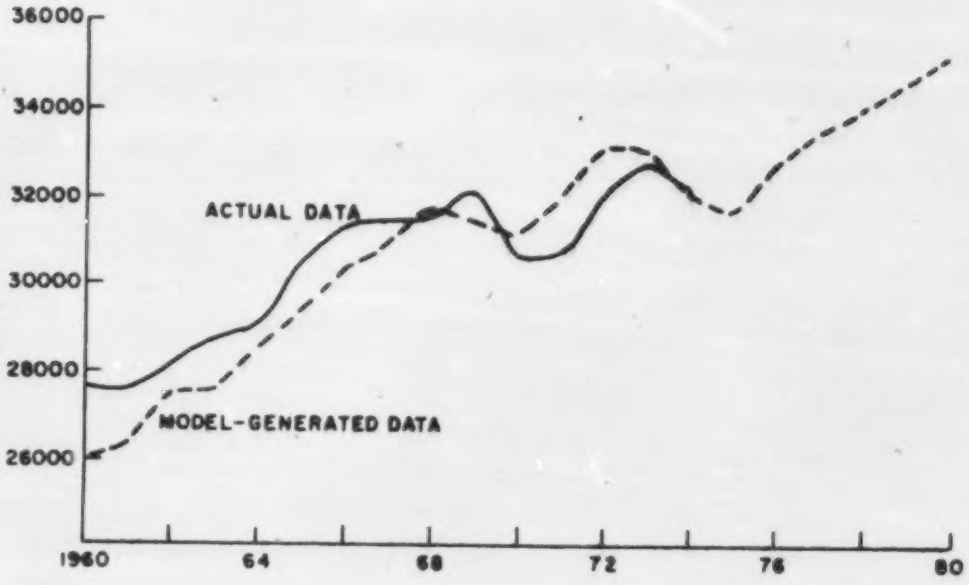

Figure 18. Actual vs Model-Generated Employment; Non-Durable Goods

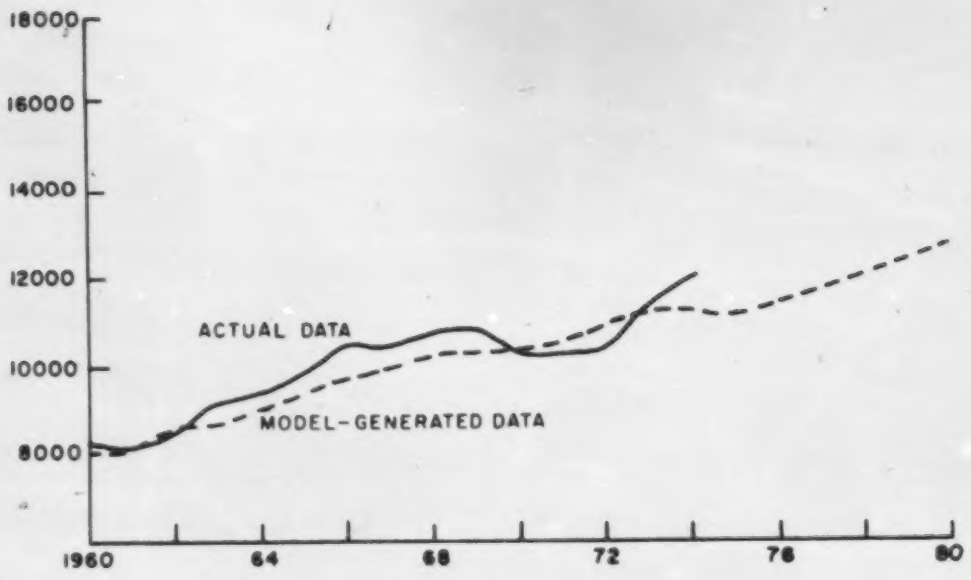

Figure 19. Actual vs Model-Generated Employment; Durable Goods

STUDENT ENROLLMENTS AND EDUCATIONAL COSTS SECTORS

Two validity checks were made in the enrollment and cost sectors to determine if the model reproduced historical data reasonably accurately. These were: a comparison of model-generated and actual number of high school graduates, and a comparison of model-generated and actual total educational costs.

The comparison of high school graduates is provided in figure 20. The difference after 1964 may be attributable to the fact that the model uses a constant, estimated high school dropout rate over the fifteen-year period, when perhaps the number of dropouts may be fluctuating annually. Before 1964, the data show a large increase in number of high school graduates between 1963 and 1964 in both public and non-public sectors, which may be due to reporting inaccuracies before 1964. The standard run of the enrollment sector assumes that the National and State unemployment rates will be equal from 1977 to 1985.

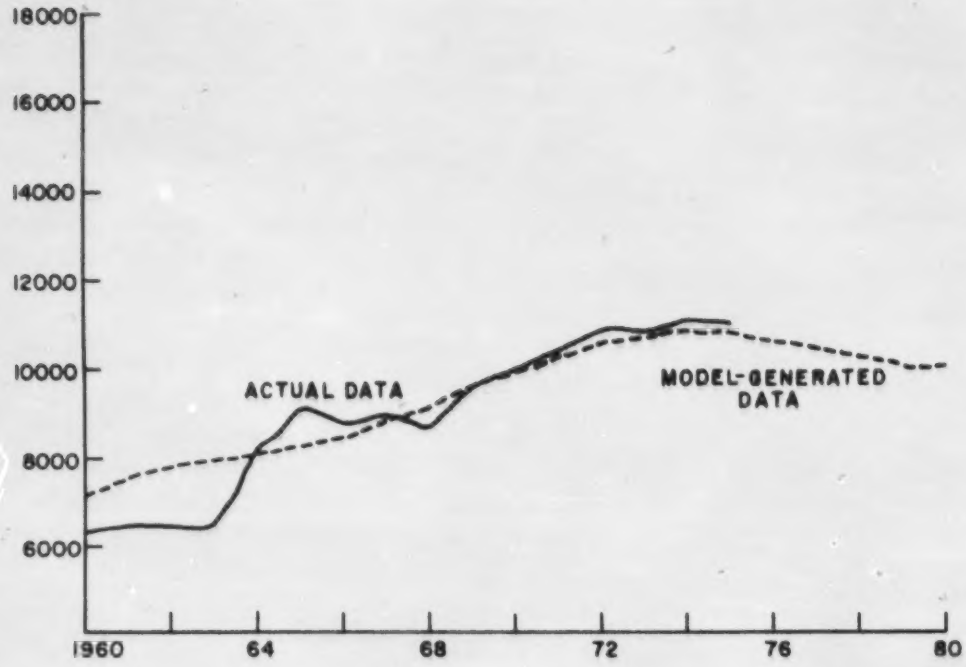

Figure 20. Actual vs Model-Generated High School Graduates

The equation for instructional costs is the major factor determining total costs in the model, and includes average teacher wage, teacher/student ratios, and costs of instructional materials. In order to achieve some agreement between actual and model-generated total costs, it was necessary to apply a correction factor to the instructional costs equation, indicating that additional factors should be included in the cost sector to make it valid. There are at least two sources of error: (1) the use of an average teacher wage, which may not accurately reflect salaries based on advanced degrees or years of teaching experience; and (2) the increasing number of non-teaching professional and para-professional personnel in school districts, such as supervisors, guidance counselors, teacher aides, clerical personnel, etc. This sector needs to be expanded to include a consideration of other educational costs, although it is still usable in conducting model experiments. The standard run of the educational costs sector (figure 21) assumes that the teacher/student ratios will remain constant until 1985 and that teacher wages will not be increased, except for cost-of-living adjustments.

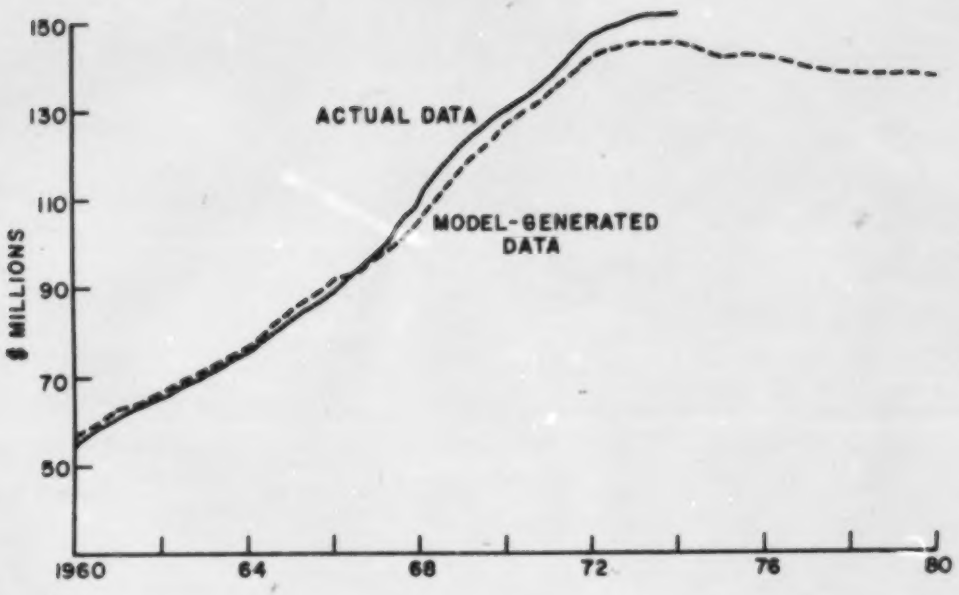

Figure 21. Actual vs Model-Generated Total Educational Costs

VALIDATION SUMMARY

Model-generated values and actual data were compared in this section in order to test the validity of the simulation model. It must be recognized that a model is always a simplification of the real system it represents, and that every system contains a certain degree of random and uncertain behavior which is not accommodated in the model. Nonetheless, the population, labor market, and enrollment sectors are sufficiently accurate to enable users to experiment with policy alternatives. Additional data must be incorporated in the educational costs and benefits sectors, although these sectors can be used in their present state if their limitations are understood.

CHAPTER IV

USING THE MODEL

Rhode Island Model II has been developed in an on-line, interactive mode, which permits use of remote computer terminals, linked by telephone to the Brown University Computer Center. This method has significant advantages for an administrator. Not only are numerous data series readily available, but experiments can be conducted in a matter of minutes by changing the values of the model variables or their relationships. The impact of current policies on future system behavior as well as the influence of potential policies can be analyzed in successive runs of the model. The model can be used to answer "what if" questions of two types: (1) what if certain variables which are not very controllable take on certain values; and (2) what if we set the values of the critical and controllable parameters at certain levels? This chapter presents the results of several experiments conducted by varying parameter values that are both controllable and uncontrollable at the State educational level.

IMPACT OF THE NATIONAL ECONOMY ON RHODE ISLAND'S LABOR MARKET

The model's equations for all occupational clusters, except Textile Manufacturing and Health Services, were developed such that changes in either gross national product (GNP) or per capita income (PCI), or both, cause employment changes in the cluster. Any changes in the values of these two variables, which are not very controllable at the State level, would have a major impact on employment and, consequently, on manpower demand. The standard run of the model uses the Bureau of Labor Statistics forecast assumptions for these variables; i.e., that the gross national product will increase 4.6 percent annually until 1980 and 3.2 percent annually from 1980 to 1985, and that real per capita income will increase 2.5 percent annually until 1980 and 2.0 percent from 1980 to 1985. To show the usefulness of the model, two variations of the standard run are presented. The first variation assumes that gross national product will increase only 3.2 percent annually until 1985, which is considered the minimum growth essential to absorb new entrants in the labor force, and that per capita income will increase only 1.0 percent annually until 1985 due to the effects of inflation. The second variation assumes that gross national product will increase 6.0 percent annually until 1980 (a goal of President Carter) and 4.6 percent annually from 1980 to 1985, and that real per capita income will increase 4.0 percent annually until 1980 and 3.5 percent annually from 1980 to 1985 (which was the State's experience between 1965 and 1970. The effects of these

variations on total employment in the State is shown in figure 22.

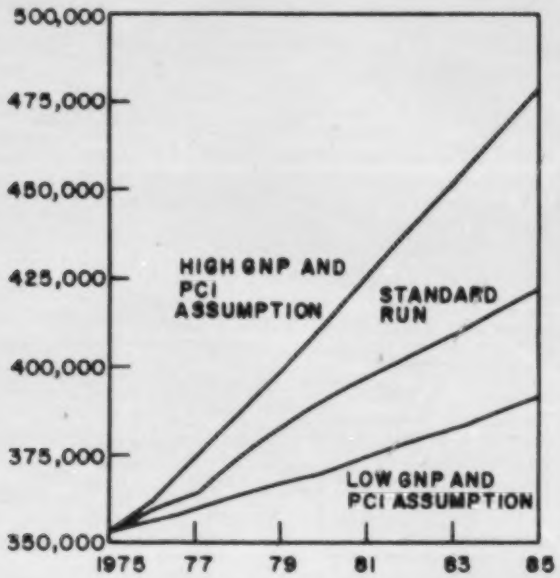

Figure 22. Model-Predicted Effects on Total Employment of Variations in Gross National Product (GNP) and Per Capita Income (PCI)

Under the Bureau of Labor Statistics assumption, Rhode Island's labor force would increase by approximately 6200 jobs annually; under the low gross national product and per capita income assumption, by approximately 3400 jobs; and under the high gross national product and per capita assumption, by approximately 11,600 jobs.

Tables 6 and 7 compare the average number of job openings under each assumption by skill level and by occupational cluster. These openings do not include replacement needs due to deaths, retirements, etc.

Table 6.
Model-Predicted Average Annual Job Openings by Skill Level

Skill Level	Standard Model Run	Low GNP & PCI run	High GNP & PCI run
I	1200	800	2000
II	650	385	1150
III	2450	1370	4500
IV	1200	415	2700
V	725	400	1300

Table 7.
Model-Predicted Average Annual Job Openings by Occupational Cluster

Occupational Cluster	Standard Model Run	Low GNP & PCI run	High GNP & PCI run
Agriculture	25	10	50
Business and Office	1325	1080	1985
Communications and Media	30	10	50
Construction	-5	-235	325
Health Services	530	530	530
Hospitality and Recreation	85	35	160
Metals and Machinery	715	335	1790
Durable Goods	270	220	395
Non-durable goods	475	200	900
Jewelry and Silverware	650	445	1235
Textiles	-685	-685	-685
Marketing and Distribution	920	235	1900
Personal Services	380	380	380
Public Services	1290	730	2100
Transportation	45	-150	325

Implications for Educational and Vocational Education Planning

Tables 6 and 7 demonstrate the difficulties inherent in developing educational and vocational educational plans based on the criterion of projected manpower demand. The educational system cannot readily respond to effects of short-term fluctuations in the National economy, nor can it regulate the flow of students leaving school to accommodate periods of peak manpower demand. With changing manpower demand, employment at all skill levels is affected; some occupational clusters more than others, depending on the forecast equations. Of particular significance in table 6 is the larger percentage decline in Skill Level IV jobs during periods of slow economic activity, primarily affecting the entry of youth into the labor force.

The outputs of these various runs could assist educators in developing plans for a minimum-maximum number of graduates by skill level to ensure a skilled manpower pool in Rhode Island, or in emphasizing specific occupational clusters for educational program formulation.

STATE ECONOMIC CONDITIONS RELATIVE TO THE U.S. ECONOMY

A second set of model experiments was conducted by varying the State's unemployment rate relative to the National unemployment rate to determine the effect on Rhode Island's population. A basic assumption of the model is that economically motivated migration is an equalizing force between different regions of the country in times of recession, and between manpower supply and demand. The relative unemployment rate was set at zero for the standard run, and then was varied in two other runs so that

the State's unemployment was 1 percent lower and 1 percent higher than the National average. The higher Rhode Island unemployment rate would mean that the State's economy lagged the National average, which was the case during the 1950s and early 1960s. A lower State unemployment rate could conceivably be achieved with the addition of new industries in the State; such as, Electric Boat Company or industries for offshore oil exploration and development.

The following graph, figure 23, compares the results of three model runs for four population cohorts. It has been assumed that the members of the over-65 population cohort do not migrate for job-related reasons.

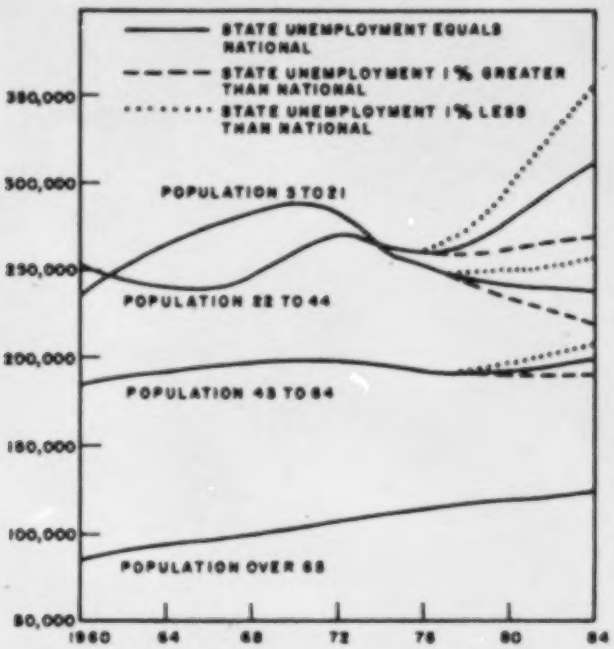

Figure 23. Model-Predicted Population by Cohorts with State Unemployment Rate Equal to National Rate, Greater than the National by 1 Percent, and Less than the National by 1 Percent

Implications for Educational Planning

Figure 23 shows job-related migrations to be concentrated in the school-age cohorts (5 to 21 years of age) and younger adult cohorts (22 to 44 years of age). As a result of this, not only would projected school enrollments vary, but there would also be a decline in the younger adult population, which would affect the available tax revenues. Another result of this would be an increase in the non-parent population, or in parent population whose children have already completed schooling. This would likely affect the willingness of taxpayers to

support educational budgets. The recent decline in Rhode Island's total population and the loss of its younger population (due to the closing of Navy bases in the State and due to the State's high relative unemployment rate) could be a contributing factor (though not the only one) to the growing reluctance of taxpayers to support education.

EXPLORING EDUCATIONAL ALTERNATIVES

Several model experiments were designed to determine the effects of policy alternatives on total educational costs. The standard run of the model assumes that wages, teacher/student ratios, State/local share ratios, and Federal contributions will remain constant from 1976 to 1985.

In the first experiment, the average State share ratio was increased to 40 percent from 36 percent beginning in 1977. Since no other factors were considered, the effect was simply to shift more of the tax burden to the State with minimal relief on local property taxes as shown in figure 24.

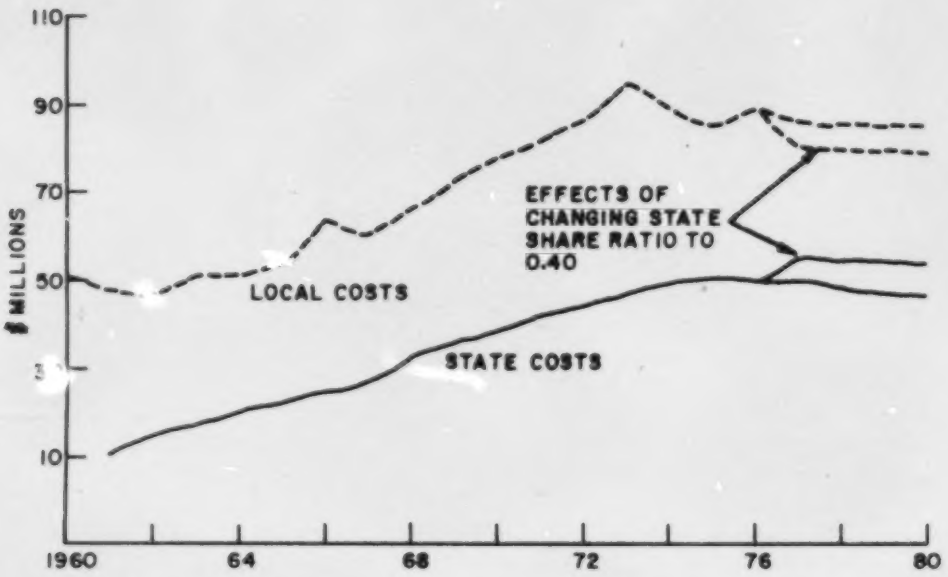

Figure 24. Average State Share for Education Increased to 40 Percent (from 36 Percent) Beginning 1977

The second experiment assumed that the teacher/student ratio would drop by 0.5 students per year during the period 1975-1979. The increase in educational costs is shown in figure 25.

The third experiment assumed that average teacher wage would increase by $500 (CPI adjusted) per year during the period 1977-79, with teacher/student ratios remaining constant. The effect on total costs is shown in figure 26.

Implications for Educational Planning

Simple experiments, such as these, can be performed very quickly (in minutes) with the model. The standard run demonstrates that educational costs (in real dollars) could conceivably decline with fewer students in the future as long as the average teacher wage and teacher/student ratios remain constant. However, any increases in one or both of these factors would more than offset anticipated savings, as indicated in the graphs for the alternative runs (figures 25 and 26).

Similarly, controllable educational variables such as costs, wages, and number of professional positions could be set at certain levels and experimented with in terms of goals to be attained or implications of various decisions or actions. Further disaggregation of cost data and inclusion of other factors is warranted to explore more fully a range of policy alternatives. Model improvements and design of experiments are best done with a group of educational administrators representative of various program and budget perspectives.

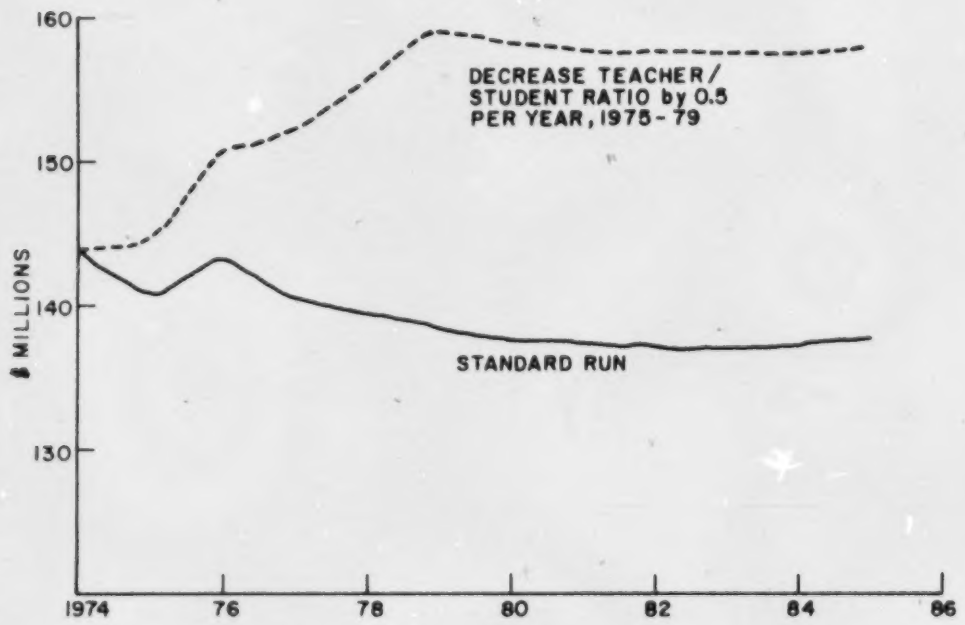

Figure 25. Effect of Teacher/Student Ratio Drop by 0.5 During the Period 1975-1979

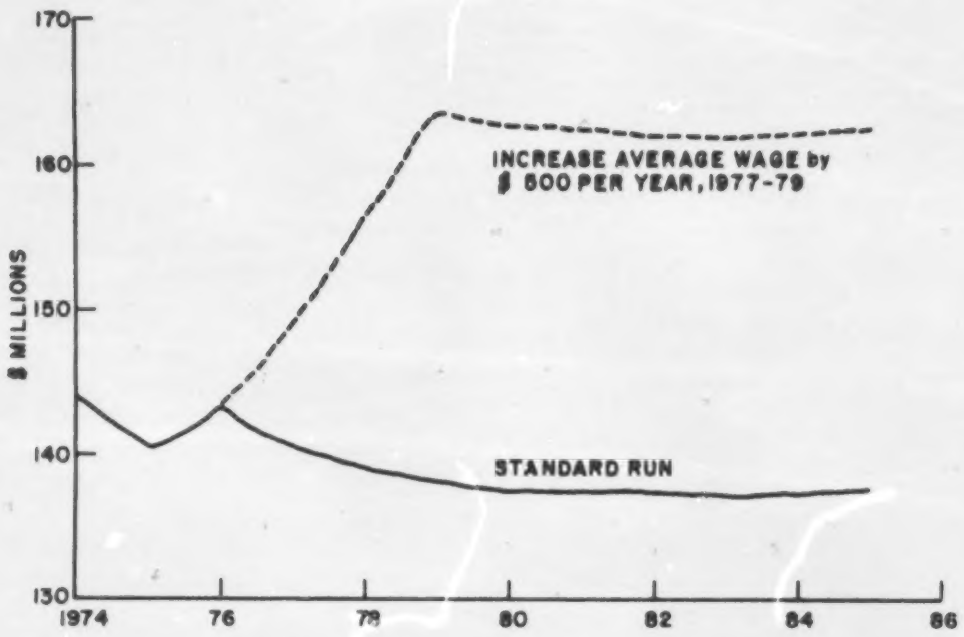

Figure 26. Effect of Increase in Average Teacher Wage by $500 per Year During the Period 1977-1979

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The stated objectives of the project were: (1) to establish a common demographic, manpower, and educational data base; (2) to develop a mechanism for improving interagency communication and coordination; and, (3) to create an analytic and educational planning tool. Conclusions in this chapter are drawn primarily on the extent to which the project accomplished these objectives.

Regarding item (1) above, appendix C provides a summary of the data that have been collected and organized in the simulation model. Population and educational data are available from 1960, and labor market data from 1950 in most cases. Many of the basic data elements, particularly demographic and manpower information, would be useful to a number of State agencies for planning purposes. It is recognized that, at least for educational planning, other demographic characteristics (such as minority population and levels of educational attainment) should eventually be incorporated in the common data core of the model.

With the model it is possible to retrieve, in a matter of minutes, specific data series (or various combinations of them) by entering the particular model sector on a remote computer terminal connected with the Brown University computer center and requesting a printout of desired variables. It is also possible to easily update data in the model by adding appropriate values to the model variables.

Regarding the second project objective -- item (2) -- an information system task force composed of representatives from various State agencies was formed. It met for the purpose of identifying the sources and availability of existing demographic, manpower, economic, and educational data, and for the purpose of developing a means for collecting information on a continuing basis. The preliminary meetings of the task force were useful in identifying interagency informational needs and improving the means for sharing available data and results of agency studies and research projects.

Regarding the third project objective -- item (3) -- the primary purpose for developing the simulation model itself was to provide the Department of Education with an analytic and planning tool. As such, the model was intended to assist the Department in analyzing the impact of different demographic and economic contingencies on the State's educational system, and in assessing the consequences of alternative educational policies. Based on the results of the validity checks and model runs reported in the previous chapters, this objective was satisfactorily attained. The model allows the simulation of manpower and educational requirements on the basis of alternate

forecasts of the behavior of the economy, shifts in the mobility and occupational composition of the labor force, and variations in the rate of growth and composition of the population. It provides a means of rapidly assessing the impact of alternative educational policies or structural changes in the behavior of the entire system. It can be used for better long-term prediction of the requirements and consequences of today's educational plans than was previously possible. It can also be used for improving educational management and control by identifying those variables that are particularly critical to system behavior and controllable by educational policymakers.

The final version of the model was not completed in time to provide an opportunity for the information system task force to review and comment on its usefulness as an analytic and planning tool. After the dissemination of this report, a first step will be to reconvene the task force in order to obtain its comments, and to explore ways in which the model could be modified to better suit the needs and purposes of other State agencies.

In addition to those conclusions drawn concerning the specified objectives of this program, there are some to be made regarding cost-effectiveness and usability of Rhode Island Model II, itself. A major purpose of this project was to explore less costly methods by which educational planning and control information could be made available to planners and policymakers. Annual costs to maintain Rhode Island Model II would be less than the salary of a full-time data analyst, or approximately $8400. This estimate includes rental costs of a terminal ($1900), part-time computer programmer and systems analyst fees ($4000), and computer time ($2500). Computer time costs are variable depending on the number of simulation runs that are made. As an example, one run of the existing elementary/secondary model, which includes the population, enrollment, costs and benefits sectors, costs $5.30. One run of the labor market sector costs $2.30. These costs can be cut in half by using the Brown University computer on weekends or in the evenings because of Brown's time-variable rates for users.

In relation to model usability, or the degree to which the model might actually be applied as a tool by State administrators, it is important to note that Rhode Island Model II uses a programming language called SMT. SMT is a flow-chart-oriented language rather than an equation-oriented one. It is therefore easier to understand for a non-technically oriented administrator. After a short training session in model configuration and computer editing commands, an administrator can alter the values of the model variables and parameters to make successive model runs or to select specific outputs for analysis. This should ensure that one of the major shortcomings of computer simulation models -- the fact that they are simply not used by the individuals they are intended to help -- does not apply to Rhode Island Model II.

RECOMMENDATIONS

The following recommendations do not suggest any substantive educational policy changes for the State of Rhode Island. Further experiments would have to be designed by administrators and tested in successive model runs before any such recommendations are made. Instead, the following suggest ways that Rhode Island Model II can be presently put to use and improved by the Department of Education. They are listed in order of priority.

a. Conduct in-service training sessions for departmental staff in the Budget Office, Bureaus of Vocational Education, Postsecondary Education, and Research, Planning and Evaluation regarding the model's use and applications.

b. Add a postsecondary enrollment and cost sector to the model. Some of the population and enrollment variables for such a sector, and their relationships, have been included in the present model.

c. Disaggregate vocational education enrollments by area school and by vocational program, and interface manpower demand with the number and type of vocational school graduates.

d. Add an "other" manpower training sector to determine training by other sources (such as CETA and proprietary schools) and their relationship to anticipated manpower demand.

e. Submit the model's economic forecast assumptions and Standard Occupational Classification (SOC) coefficients for extensive review and comment by business and industry leaders and by the State Manpower Services Council.

f. Add a State revenue and tax sector to provide an estimate of anticipated revenues and the consequences of moving away from property taxes as the primary source of educational funds.

g. Develop an urban educational model focusing on the changing demographic (bilingual, minority) characteristics of cities and their impact on enrollments, costs, and student achievement.

h. Add on an "education for the handicapped" sector to take into account the consequences of the new Federal and State legislation in terms of projected enrollments and costs.

The major test for any simulation model is whether or not it is used. Although the techniques of systems dynamics modeling have been available for the past fifteen years, not many simulation models have been actually implemented and used by policymakers. The major stumbling block seems to be the difficulties in communication between the model-builders, who use mathematical symbolic models, and model-users, who use verbal symbolic and mental models for arriving at policy decisions. The criterion on which a dynamic model should be judged is whether or not it provides an effective way of more systematically analyzing and understanding the behavior of a complex system, as compared to subjective mental and descriptive models which we would otherwise use. Of course, the authors of this report are convinced that Rhode Island Model II does provide one such effective, as well as usable, technique.

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APPENDIX A

GENERAL INFORMATION ON SIMULATION MODELS

The purpose of a simulation model is to provide a framework for analyzing information or for explaining factors that cause or sustain a problematic state of affairs. As stated in Chapter I, a computer model differs only in complexity, precision, and explicitness from the informal subjective explanation or "mental model" that persons ordinarily construct to guide their actions toward a goal and to make decisions. Simulation models are normally constructed to assist long-range planning and analysis, to make projections, or to improve system management and control. Planning by simulation is an attempt to reconstruct the structure and behavior of a complex system, such as an educational system, in order to understand its functioning and, consequently, to anticipate alternative futures. Experience with simulation models in many other fields indicates that they can be extremely useful in this role.

A simulation model is one type of mathematical model, which is constructed by formulating equations describing system components and system states. Equations, in turn, are composed of variables, constants, and parameters. Variables assume different values while the model is run or calculated. Two sets of variables affect the behavior of the model. The first set is endogenous to the system; i.e., the system itself determines the value of the variable. The initial conditions or parameters of these variables are set or estimated by collecting and analyzing a wide range of data. The second set of variables is exogenous; i.e., their values are determined by conditions in the environment. In most cases, these are policy variables or decision functions which can be manipulated by planners or policymakers to affect the behavior of the model. Varying the decision functions and model assumptions in successive runs enables the user to assess the impact of alternative policies or structural changes in the model at different points in time. Thus, simulation models are dynamic models, which express the dynamic relationships among the variables, constants, and parameters.

A simulation model constructed and used by a policymaking group has these advantages:

a. It can serve as a basis of <u>intra- or interagency communication and coordination</u>. Demographic, manpower, economic and educational data are generated by a wide variety of Federal, State, and local agencies. The information is usually compiled in response to the demands and reporting requirements of the next hierarchal level in each institution. Too often, the data must be "crosswalked" or adapted to be useful to other agencies. The simulation model can assist the process of developing information usable by many agencies.

b. The model produces valuable insight into the structure and behavior of a complex system. As has been demonstrated in industrial and other models, highly complicated systems often behave in ways that would be difficult to predict intuitively, often in the inverse of what might be initially expected. But once one understands how the system's behavior is conditioned by its structure, it is possible to see how to most effectively use the system to produce the results most desired by society.

c. The model provides a means of assessing the impact of alternative policies or structural changes in the behavior of the entire system in a matter of minutes. Thus, for planning purposes, a host of possibilities can be visualized and examined with much less effort and less cost than ever before.

d. The model is a means for better long-term prediction of the requirements and consequences of educational plans today. Funds which will be needed in the future, staff requirements, facilities, and so on, can be projected for several years. More importantly, the side effects of a program, small and unnoticeable at first, but which become significant several years hence, can be foreseen and accommodated.

e. The model is a tool for analyzing the effects of external changes. Population shifts, industry relocations, technological changes, and periods of economic growth and recession can be simulated easily and conveniently, suggesting the best way for the district to respond to each of these contingencies.

Simulation models are usually validated by evaluating:

a. the degree to which a model duplicates past system behavior when historical data are used as input;

b. the degree to which model behavior conforms to existing and relevant theory;

c. the degree to which the model accurately forecasts future system as it unfolds; and

d. the degree to which the model is found acceptable to those who will use it.

Jay Forrester, a recognized authority in systems modeling, has made the following comments with respect to any model's validity and usefulness:[16]

> "The validity and usefulness of dynamic models should be judged, not against an imaginary perfection, but in comparison with the mental and descriptive models which we would otherwise use. We should judge the formal models by their clarity of structure and compare this clarity to the confusion and incompleteness so often found in a verbal description. We should judge the models by the certainty with which they show the correct time-varying consequences of the statements made in the models compared to the unreliable conclusions we often reach in extending our mental image of system structure to its behavioral implications. We should judge the models by the ease of communicating their structure compared to the difficulty in conveying a verbal description."

APPENDIX B

DEFINITION OF U.S. DEPARTMENT OF LABOR STANDARD INDUSTRIAL CLASSIFICATION CODES AND CONVERSION TO USOE OCCUPATIONAL CLUSTERS

USOE OCCUPATIONAL CLUSTER	SIC CODE	SIC TITLE
Agri-Business and Natural Resources	01	Agricultural Production-Crops
	02	Agricultural Production-Livestock
	07	Agricultural Services
	08	Forestry
Business and Office	60	Banking
	61	Credit Agencies other than Banks
	62	Security, Commodity Brokers, and Services
	63	Insurance Carriers
	64	Insurance Agents, Brokers, and Services
	65	Real Estate
	66	Combined Real Estate, Insurance, etc.
	67	Holding and Other Investment Offices
	73	Business Services
	82	Educational Services(Private)
	86	Membership Organizations
	89	Miscellaneous Services
	81	Legal Services
Communications and Media	48	Communications
	481	Telephone Communications
	482	Telegraph Communications
	483	Radio and Television Broadcasting
Construction	15	General Building Contractors
	16	Heavy Construction Contractors
	17	Special Trades Contractors
Health	80	Health Services
Hospitality and Recreation	78	Motion Pictures
	79	Amusement and Recreation Services

USOE OCCUPATIONAL CLUSTER	SIC CODE	SIC TITLE
Manufacturing		
Metals and Machinery	33	Primary Metal Industries
	34	Fabricated Metal Products
	35	Machinery, except Electrical
	36	Electrical and Electronic Equipment
Jewelry and Silverware	391	Jewelry, Silverware, and Plated Ware
Textiles	22	Textile Mill Products
	23	Apparel and Other Textile Products
Non-Durable Goods	20	Food and Kindred Products
	21	Tobacco Manufacturers
	26	Paper and Allied Products
	27	Printing and Publishing
	28	Chemicals and Allied Products
	29	Petroleum and Coal Products
	30	Rubber and Miscellaneous Plastics Products
	31	Leather and Leather Products
Durable Goods	24	Lumber and Wood Products
	25	Furniture and Fixtures
	32	Stone, Clay, and Glass Products
	39	Miscellaneous Manufacturing Industries
	38	Instruments and Related Products
Marine Occupations	091	Commercial Fishing
	44	Water Transportation
	373	Ship and Boat Building and Repairing
Marketing and Distribution	50	Wholesale Trade - Durable Goods
	51	Wholesale Trade - Non-Durable Goods
	52	Building Materials and Garden Supplies
	53	General Merchandise Stores

USOE OCCUPATIONAL CLUSTER	SIC CODE	SIC TITLE
Marketing and Distribution (cont'd)	54	Food Stores
	56	Apparel and Accessory Stores
	57	Furniture and Home Furnishing Stores
	59	Miscellaneous Retail
Personal Services	58	Eating and Drinking Places
	70	Hotels and Other Lodging Places
	72	Personal Services
	76	Miscellaneous Repair Services
	88	Private Households
Public Services	43	U.S. Postal Service
	49	Electric, Gas, and Sanitary Services
	82	Educational Services (Public)
	83	Social Services
	84	Museums, Botanical, and Zoological Gardens
	91	Executive, Legislative, and General
	92	Justice, Public Order, and Safety
	93	Finance, Taxation, and Monetary Policy
	94	Administration of Human Resources
	95	Environmental Quality and Housing
	96	Administration of Economic Programs
Transportation	40	Railroad Transportation
	41	Local and Inter-Urban Passenger Transit
	42	Trucking and Warehousing
	45	Transportation by Air
	46	Pipe Lines, except Natural Gas
	37	Manufacturing, Transportation Equipment
	55	Automotive Dealers and Service Stations
	75	Automobile Repair, Services, and Garages

APPENDIX C -- SUMMARY/SOURCES OF DATA FOR RIM II

DATA ELEMENT	YEAR	SOURCE
Population Sector		
1. R.I. Population by Age and Sex	1960, 1970	R.I. Census Special R.I. Census Estimates provided by Statewide Planning Program, Department of Administration
2. Annual Resident Births by Age of Mother	1960-1974	R.I. Department of Health, Division of Vital Statistics
3. Annual Resident Deaths by Age and Sex	1960-1974	R.I. Department of Health, Division of Vital Statistics
4. Out-of-state Students in R.I., Undergraduate and Graduate	1958	Home State and Migration of American College Students, Fall, 1958 (Reference 5)
	1968	Residence and Migration of College Students, Fall, 1968 (Reference 6)
	1972	Student Enrollment in New England Institutions of Higher Education (Reference 7)

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DATA ELEMENT	YEAR	SOURCE
5. Rhode Island Students Attending Out-of-state Schools	1958, 1968	Student Enrollment in New England Institutions of Higher Education (Reference 7)
	1963	Residence and Migration of College Students, Fall, 1968 (Reference 6)
6. Out-of-state Undergraduates, Brown University	1960-1974	Annual College Bulletins, Brown University.
7. Out-of-state Undergraduates, University of Rhode Island	1960-1966 1967-1974	Thibeault Commission Report Registrar, University of R.I. (Reference 17)
8. National/State Unemployment Rates	1960-1973	Basic Economic Statistics, 1975, R.I. Department of Economic Development
9. Military Population in R.I.	1960-1975	U.S. Department of Defense
10. Military Population by Age and Sex	1960-1970	R.I. Census: 1960 and 1970
11. Navy Dependent Ratios	1960-1975	U.S. Department of Defense
12. Commuter Housing Movers	1960,1970	U.S. Census for Connecticut, Massachusetts, and Rhode Island
13. Level of Educational Attainment by Age and Sex	1960,1970	R.I. Census: 1960 and 1970
Labor Market Sector		
1. Total Employment - Construction	1950-1974	R.I. Department of Labor
2. Total Employment - Manufacturing	1950-1974	R.I. Department of Labor

3.	Total Employment - Metals & Machinery	1960-1974	R.I. Department of Labor
4.	Total Employment - Jewelry & Silverware	1950-1974	R.I. Department of Labor
5.	Total Employment - Textiles	1950-1974	R.I. Department of Labor
6.	Total Employment - Non-Durable Goods	1950-1974	R.I. Department of Labor
7.	Total Employment - Durable Goods	1950-1974	R.I. Department of Labor
8.	Total Employment - Business & Office	1950-1974	R.I. Department of Labor
9.	Total Employment - Communications & Media	1950-1974	R.I. Department of Labor
10.	Total Employment - Health Services	1958-1974	R.I. Department of Labor
11.	Total Employment - Hospitality & Recreation	1958-1974	R.I. Department of Labor
12.	Total Employment - Marketing & Distribution	1950-1974	R.I. Department of Labor
13.	Total Employment - Personal Services	1950-1974	R.I. Department of Labor
14.	Total Employment - Public Service	1950-1974	R.I. Department of Labor
15.	Total Employment - Marine Occupations	1950-1974	R.I. Department of Labor
16.	Total Employment - Transportation	1950-1974	R.I. Department of Labor
17.	Covered Employment - Agriculture and Natural Resources	1958-1974	R.I. Department of Employment Security

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DATA ELEMENT	YEAR	SOURCE
18. R.I. Real Per Capita Income (1967 = 100)	1950-1974	Federal Reserve Bank of Boston, New England Econometric Model
19. GNP Implicit Price Deflation (1967 = 100)	1950-1974	Survey of Current Business, U.S. Department of Commerce (Reference 19)
20. Real Gross National Product	1950-1974	Handbook of Labor Statistics Bulletin No. 1865, U.S. Department of Labor (Reference 18)
21. R.I. Real Gross State Product	1950-1974	Federal Reserve Bank of Boston, New England Econometric Model
22. R.I. Relative Wage - Manufacturing	1950-1974	Employment and Earnings: State & Areas, U.S. Department of Labor, Survey of Current Business, U.S. Department of Commerce (Reference 19)
23. R.I Relative Wage - Metals and Machinery	1958-1974	Same as above
24. R.I. Relative Wage - Textiles	1958-1974	Same as above
25. R.I. Relative Wage - Jewelry & Silverware	1958-1974	Same as above
26. R.I. State Sales Tax	1953-1974	R.I. Division of Taxation
27. R.I. Corporate Tax Ratio	1950-1974	The Book of States (Reference 20)
28. R.I. Financial Institution Tax Ratio	1950-1974	The Book of States (Reference 20)

29.	Price Index - Contract Construction	1950-1974	Survey of Current Business (Reference 19)
30.	Productivity Index - Textiles	1950-1974	Survey of Current Business (Reference 19)
31.	Productivity Index - Contract Construction	1950-1974	Survey of Current Business (Reference 19)
32.	Productivity Index - Agriculture	1950-1974	U.S. Economy in 1985, BLS Bulletin #1809, U.S. Department of Labor (Reference 21)
33.	Productivity Index - Manufacturing	1950-1974	Survey of Current Business (Reference 19)
34.	Productivity Index - Durable Goods	1950-1974	Survey of Current Business (Reference 19)
35.	Productivity Index - Non-Durable Goods	1950-1974	Survey of Current Business (Reference 19)
36.	Productivity Index - Transportation	1950-1974	U.S. Economy in 1985, BLS Bulletin No. #1809, U.S. Department of Labor (Reference 21)
37.	Productivity Index - Communications	1950-1974	Same as above
38.	Productivity Index - Marketing & Distribution	1950-1974	Same as above
39.	Productivity Index - Forecasts	1972-1980 1980-1985	Same as above
40.	R.I. State Expenditures - Health	1958-1974	Federal Reserve Bank of Boston, New England Econometric Model
41.	R.I. State Expenditures - Public Welfare	1958-1974	Federal Reserve Bank of Boston, New England Econometric Model

DATA ELEMENT	YEAR	SOURCE
42. R.I. State Capital Outlay for Construction	1950-1974	Federal Reserve Bank of Boston, New England Econometric Model
43. Industry of the R.I. Labor Force by Age and Sex	1960, 1970	R.I. Census: 1960 and 1970
44. Occupation of the R.I. Labor Force by Age and Sex	1960, 1970	R.I. Census: 1960 and 1970
45. Occupation by Industry - Matrix by Sex	1960, 1970	R.I. Census: 1960 and 1970
46. Occupation of Employed Persons by Education and Sex	1960, 1970	R.I. Census: 1960 and 1970
Enrollment Sector		
1. Public Elementary & Secondary Enrollments	1960-1975	R.I. Department of Education, Statistical Tables (Reference 12)
2. Parochial and Private School Enrollments	1960-1975	Rhode Island Department of Education, Undergraduate Enrollment Projections, 1977-1993 (Reference 13)
3. Area Vocational School Enrollments	1966-1975	R.I. Department of Education, Statistical Tables (Reference 12)
4. R.I. Junior College Vocational Enrollments	1965-1975	R.I. Department of Education, Thibeault Commission Report (Reference 17)

Educational Costs

1. Total Expenditures	1960-1975	R.I. Department of Education, Statistical Tables (Reference 12)
2. Federal/State/Local Ratios	1960-1975	R.I. Department of Education Statistical Tables (Reference 12)
3. Teacher/Students Ratios, Elementary and Secondary	1960-1975	R.I. Department of Education Statistical Tables (Reference 12)
4. Average Teacher Wage	1960-1975	R.I. Department of Education Statistical Tables (supplement) (Reference 12)
5. Costs by Major Category of Expenditure	1960-1975	R.I. Department of Education, Statistical Tables (Reference 12)

Educational Benefits Sector

1. Average Wage by Level of Educational Attainment, Male and Female, Ages 25-34	1970	R.I. Census
2. Average Wage by Vocational Education Program, Male and Female, All Ages	1970	R.I. Census

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